VILLAGE HEALTH

A GUIDE FOR TEACHERS

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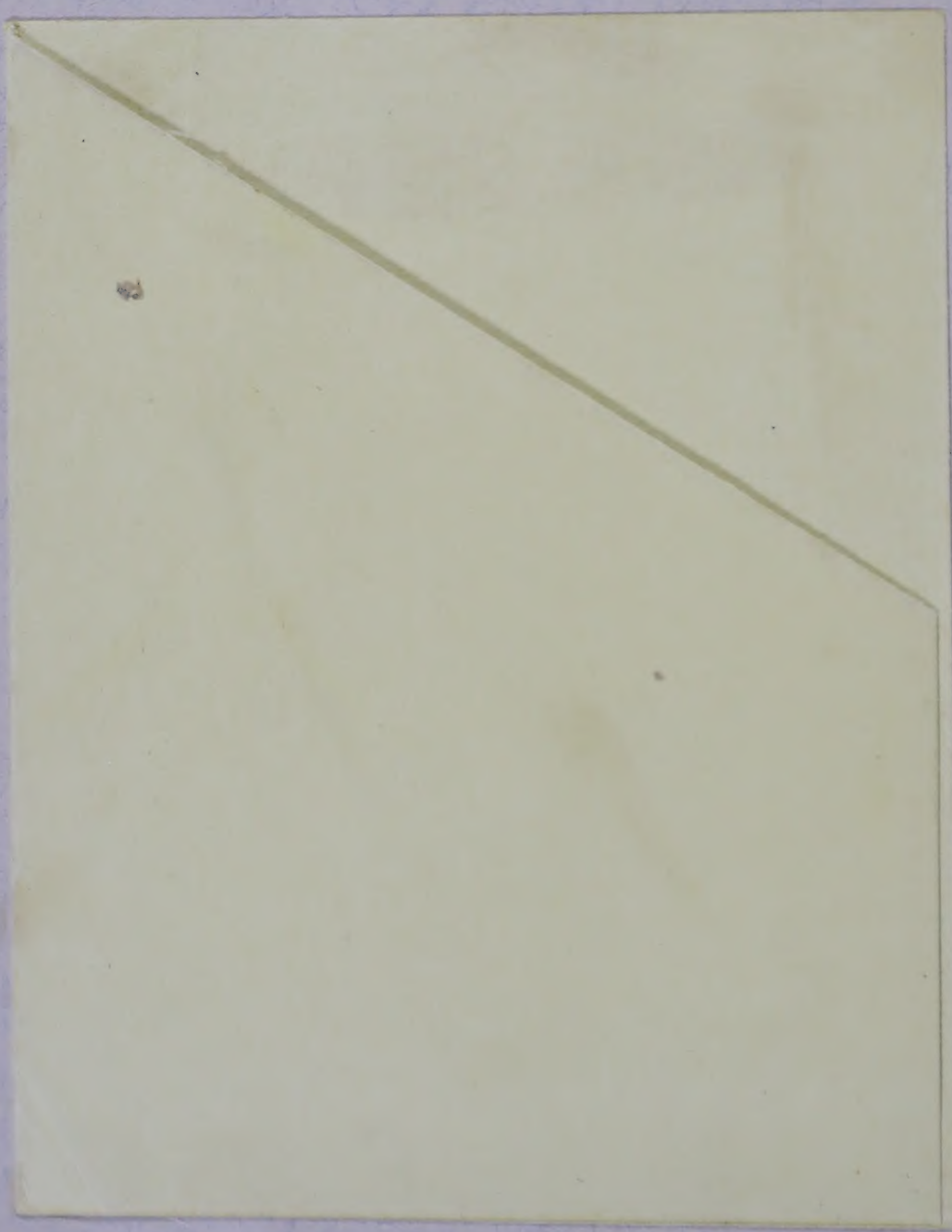

VILLAGE HEALTH

A GUIDE FOR TEACHERS

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PREFACE

There is nothing original in this book. It is born of my lecture notes for several courses given for teachers and other village workers during the past three years at Sevagram. The material is drawn from the sources listed in the bibliography. Some of the material was previously published in Nai Talim magazine.

The purpose of the book is to make available in one brief manual the minimum scientific material required to solve the main health problems of an isolated Indian village.

I am grateful to the staff of Hindustani Talimi Sangh for their co-operartion. In particular should be mentioned Prof. Maeda and Devi Prasad for the illustrations, Shri S. S. Gokhle B. A. B. T. for reading the proof and my wife for putting my writing into legible form.

Sevagram
February 1, 1958

Elton Kessel

FOREWORD

The children of India, which means the children of the villages and slums of India, for that is where most of our nation's children live and grow, offer, to my mind, one of the greatest moral challenges in the life of our nation. Their eyes, noses and ears may be running, they may have lice in their hair and some kinds of germs growing in their little bodies, yet they are always ready with laughter and play, always bright-eyed, quick and sensitive. Our children are always hungry–hungry not only for better food but also for understanding and affection. They are our greatest national treasure and their neglect is one of our greatest national tragedies.

It has always been our dream to develop a Research Institute at Sevagram, which would study the Indian Child as a whole–his health, his poverty, his social and cultural environment and his personality–a Research Centre which would also work towards and evolve a programme for an allround integrated development of the Indian child within the limits of our national resources, in material and trained personnel.

Whenever an opportunity arose, I tried to meet and speak to young doctors, social workers and teachers and appeal to them to help us in this task. I must confess, however, that I was not successful. Perhaps, I was too unfortunate.

The first response to this appeal came unexpectedly in Chicago, U. S. A. Dr. and Mrs. Kessel met me in the International House in Chicago and offered to come to Sevagram and help us in this work at their own expense. They decided to stay another year in Chicago to qualify themslves better for their future work–he in tropical diseases and she as a laboratory technician. Dr. Kessel worked to earn just enough to cover their travelling expenses both ways and their living expenses in India for three years. They bought and fitted up an old station wagon and started on their overland journey towards Sevagram with their baby–son across Europe and Asia.

One afternoon in February, 1955 the Kessel family arrived at Sevagram in their much-travelled station-wagon and joined the Community. For three years, the Kessels lived and worked as members, not only of Sevagram community of workers, students and villagers, but of the wider community of the surrounding villages. When he left in 1958 he was the much loved doctor and family friend of forty villages round Sevagram.

Dr. Kessel brought to his work not only his scientific knowledge but a deep love of men, women and children and the rare quality of humility and readiness to learn. He spent his first year in a study of the health problems of the villages round about Sevagram, not separately, but as integral parts of the problems of Indian village life. He came to the conclusion that most of the health problems of Rural India could be solved by the supply of pure drinking water, sanitation and right type of food and all this had to be achieved within the

economic resources of Indian villages today. He therefore concentrated his work round experiments with:—

(i) fly-proof odourless village latrines and urinals,

(ii) simple inexpensive disinfection of drinking water,

(iii) balanced diet within the resources of an Indian village.

Before he left, he had evolved the portable type of village latrine, which is known in the surrounding villages as "Kessel Latrine", had introduced cheap bottles of chlorine in village homes and schools and made many experiments with village balanced diets.

Dr. Kessel was convinced that the problem of our national health could be solved to a large extent by the right type of education, and the village schools could be developed as spearheads in our battle against national ill-health, which was due not only to our poverty, but to a great extent to our ignorance.

He therefore, gave much of his thoughts and energies to the training of teachers of the basic schools in the compact area surrounding Sevagram.

He conducted intensive training courses and followed up these courses by continuous visits to the basic schools and villages to supervise and guide the practical implementation of the training.

This book is based on his three years' experience of rural health work through basic schools and has been planned as a text book for teachers in village schools, both basic and non-basic. We hope that it may also

prove useful to other workers engaged in programmes of rural reconstruction, whether under the auspices of the non-official organisations or the Government agencies in Community Development.

The Hindustani Talimi Sangh has much pleasure in presenting this book for the use of all workers and students of rural health problems.

Baishaki, 1959. (April, 14)
Sevagram.

Ashadevi Aryanayakam.

INTRODUCTION

Our villages are poor and over burdened with disease. The two conditions are related. Our people do not eat the minimum requirements of food for vigorous health. But it is difficult to produce this food without vigorous health. One-third of the population suffers from malaria. The decrease in working efficiency due to this disease, cannot be even estimated. But it is difficult for a sick people to take the steps to eradicate the disease. Cholera, typhoid and the other diarrheal diseases take a huge toll in life and health each year. But can a people who are so affected afford the facilities to eradicate these diseases ?

One group will propose that we increase expenditures on health first and economic efficiency will naturally rise. Another advises to raise the economic level and most of our diseases will vanish. But neither appears to be possible without the other. We believe we have the answer to this dilemma and it is education. These pages contain the necessary information to bring health to any isolated village with the present resources in the village. They should be read with this point of view in mind.

In large measure, and increasingly so, the Basic Schools in the Sevagram area, have assumed the responsibility for community health. The main health problems in the area are : (1) malnutrition, (2) diarrhea, (3) conjunctivitis, (4) malaria and (5) a host of skin diseases which are really manifestations of malnutrition. As all these diseases

are preventable, it was planned to make each of the 20 Basic Schools in our area, a model home containing all necessary facilities to eliminate these diseases from our villages. In addition a child welfare center was established to form closer contact with mothers and preschool children. Attached to the Clinic is a Home where any mother may live with her child to learn child care. It was gratifying to find that these could easily be provided within the present resources of the villages. The problem was primarily one of education.

The first step in our program was the education of our teachers in health matters. This is provided by annual two week health camps covering an intensive course in public health, nutrition, physiology and first aid. In addition the teachers are met as a group at monthly teachers' meetings and individually in the villages as frequently as time permits. Armed with this new knowledge the taechers eagerly attacked the problems. The information gained, was in turn given to the students in school and in practice.

There are two common nutritional problems in this *Jaur* growing area. First, there is the small child who is weaned too late. Breast milk contains practically no vitamin C, vitamin D or iron. The baby can get its vitamin D from sunlight and he has a six month supply of iron stored in its liver at birth. To supply vitamin C our child welfare center advises mothers to give the baby fruit juice or the juice from boiled green leafy vegetables at three months of age. For iron, *Jaur* cereal is advised at 6 months of age. The second nutritional problem is found with older children on a diet of *Jaur* and *Dal* only. This diet is deficient in vitamin A, vitamin C

and calcium. To correct this diet requires the addition of green leafy vegetables. Amaranthus is particularly rich in these three and grows well in this area. Only about one ounce per person is needed of this vegetable to balance the diet and that much can be grown in a kitchen garden using waste water. So each of our schools—the model homes—has a small kitchen garden, cared for by the students under the supervision of the school master. In a few villages the next step has been taken, namely, starting kitchen gardens at the homes of the students. In this way the idea spreads through the village. The guardians meetings offer another opportunity to spread the good word which will surely improve our childrens' health.

The diarrheal diseases are spread by stool. As we have open wells in the area, they are easily contaminated with small amounts of stool brought to the well on buckets or on the feet of our women as they walk on contaminated soil. To render the families' drinking water safe we have introduced a method of home chlorination of drinking water. In this way a family can be provided safe drinking water for about one anna a year. The children at each school use this method of water purification. The teachers encourage the parents to use it at home in the guardians meetings. Thus the method spreads through the village and beneficial results are sure to follow as they have in all communities receiving a protected water supply.

At the monthly teachers' meeting supplies of potassium permanganate are issued to each schoolmaster for treatment of wells. Measuring the capacity of the wells and amount of potassium permanganate to be used becomes a problem in arithmetic for the students and serves as an efficient method of getting this work done.

A second mode of spread of diarrheal diseases is by flies carrying stool to our food. The only practical way to lower the fly population is to eliminate their breeding places. The most important breeding place in our villages is the dung compost pits. During the health camps the teachers were given instruction in methods of composting that are both fly proof and produce high grade compost. Demonstration compost pits are then set up in the villages.

The third and most important way to reduce the incidence of diarrheal diseases is to compost stool and urine in a safe latrine. Each of our schools has such a latrine fitted with a rubber air seal. The students, who do not have a latrine at home, come to the school in the morning to use the school latrine. From the compost made in the latrine they learn that a dangerous nuisance can be converted into an economic asset of considerable value. Most of the school teachers are using this type of latrine at their own homes. The teacher's home then becomes the second model for the village.

Malaria control is essentially mosquito control. The two most important places for mosquito breeding in our villages are waste water from the bath place and stagnant pools of water along the erosion gullies after the rains. Waste water about the home is best dealt with by planting in the area. One papaya tree at each bathing place should reduce the mosquito population in half and avoid numerous cases of malaria. At each school there is a demonstration of the use of waste water. Generally the nearest well to the school is taken for a project and cared for by the students as a public demonstration to the entire village.

There are two diseases for which immunizations are offered by the government in these villages; smallpox and

cholera. It can truthfully be said that the immunizations were never properly given in this area until done in cooperation with the basic schools. A vaccinator is merely a visitor in the village. The schoolmaster is a permanent member of the community. He is generally interested in the health of the community and respected by the community. As we went door to door last year together with the schoolmaster and older students, we vaccinated 5000 children.

Concentrating on prevention of diseases is the surest road to healthy villages. But malaria, diarrhea, conjunctivitis and scabies are so common and so easily treated, and the roads to any center so difficult to pass we encourage their treatment in the village by the schoolmaster. In the health camps and at our frequent visits to the villages the schoolmasters are trained and supervised in this work. At this time the average teacher treats about 100 cases per month giving great service to the village.

Through our Basic Schools the health program grows in the villages about Sevagram. We are confident our children shall grow stronger in body and spirit through these efforts.

PART I

PUBLIC HEALTH

CHAPTER I

TYPHOID FEVER

Typhoid fever is an infection caused by a bacterium called the typhoid bacillus. Like all bacteria it is extremely small. The width of a kernel of rice is about one millimeter. If this is divided into one thousand parts it will be approximately the size of one bacterium. Naturally bacteria cannot be seen with the naked eye, but only with the aid of a microscope. In spite of their small size they are capable of causing a severe and sometimes fatal disease (10%) characterized by a continued fever lasting about four weeks, rash and diarrhœa. One attack gives immunity to future attacks, but leaves the patient in a weakened state; for three years afterwards the death rate of such persons is twice the normal rate for the same age.

Let it be clearly understood from the start that there is only one way of contracting typhoid fever, and that is by swallowing typhoid bacilli in the stool or urine of someone else. It is therefore proper to regard an outbreak of typhoid fever as a reproach to the sanitation and civilization of the community in which it occurs.

The control of this disease in the West, is one of the most notable achievements in preventative medicine. The cause, mode of transmission and prevention are well understood. Sanitation here finds a fruitful field, hygiene its useful lessons, and the study of immunity its practical

application. In 1900 in the United States, typhoid fever was responsible for 35,000 deaths in 350,000 cases. Today the figures are less than 10% of these. India today stands approximately where the United States stood over 50 years ago. The causes of this improvement in the West are the general chlorination of water supplies, cleaner milk supplies and heating of milk, preventative inoculations and the general raising of standards of personal hygiene and sanitation. Of these, chlorination of water was the single most important factor. Bacteria cannot live in chlorinated water. Neither can they live in boiled water or milk. By preventative inoculations, is meant raising the immunity of each individual by injecting dead typhoid bacilli. This is a harmless procedure but is only partially effective.

Let us now consider in more detail, the mode of infection and transmission of typhoid fever and what practical steps can be taken by village India to eradicate this menace. The typhoid bacillus, as we have said, enters the body by the mouth. It grows and multiplies in enormous numbers in the intestinal tract. It penetrates the tissues of the body. The bacteria leave the body and become available to infect others in the stool and urine. They are not only in the stool and urine of active cases of typhoid fever, but may also be carried by people who had the disease long ago and because of their immunity no longer have symptoms of the disease. The only way to detect these carriers is to send the fresh stool of suspected carriers to a bacteriological laboratory where the typhoid bacillus can be grown and identified. There are no such laboratories in village India; so this approach is not open to us. In one carefully studied case in America a cook named Mary Mallon but better known as "Typhoid Mary"

was found to be a carrier of the typhoid bacillus and is known to have spread the disease to over 1300 people.

The only hope for village India is to avoid swallowing stool and urine. Now naturally no one in his right mind would consciously do this. But the fact that everyone of us who has had a severe diarrhea, has done so, is undeniable. How is this possible ? As we have already noted that the size of bacteria is very small, actually thousands are carried on the legs of a single fly. And indeed this is an important method of spread of occasional cases. The fly first rests on the uncovered fresh stool or urine of a typhoid patient or carrier. His next stop is the food of an unsuspecting future patient, leaving hundreds of typhoid bacilli to be eaten with the food. It is as easy as that. Epidemics are caused by contaminated water or milk. In the case of water the well may be contaminated by the uncovered stool or urine of a typhoid patient or carrier being washed into the well during the rains. Or the contamination can occur underground, the stool and urine travelling from a latrine placed too close to the well. It may be carried to the well on a bucket which rested on the floor of a home where a child had a stool. Our women may carry stool to the well on their feet by stepping on contaminated earth on the way to the well. In the case of milk the contamination usually occurs from the unwashed hands of a carrier working in the kitchen. In as much as the bacteria are very small and very numerous in stool it is not difficult to raise the population of typhoid bacilli in water and milk in this way to 100 per glassful. Vegetables eaten raw, that were fertilized with night soil or freshened with contaminated water, are another source of infection.

The main defence againce typhoid fever, is the proper disposal of stool and urine in a latrine. The latrine must be so constructed and used that the contents are not exposed to flies and will not contaminate nearby water supplies. Next, the drinking water for every member of the family, taken from an open well, should be chlorinated throughout the year. Milk should be boiled before drinking or using in the preparation of milk products. Hands and feet should be washed before eating or preparing food. Vegetables eaten raw should be soaked for 15 minutes in potassium permanganate solution. Finally typhoid inoculations should be taken where offered by the health authorities.

The treatment of a patient with typhoid fever should be done by a physician. In our villages this treatment is still frequently done at home. The teacher of each village should therefore have some knowledge of isolation technique to help protect other members of the household and village. The patient must be isolated in a separate room which, if possible, should be large and well ventilated. It should contain no unnecessary furnishings. It is best that the patient lives under a mosquito net. Animals should be kept out of the sick room. Only those people concerned with the care of the patient, should be permitted to enter. They should wash their hands before leaving the room.

The patient's stool and urine should be collected in a *matka* fitted with a cover. If disinfecting agents are available such as bleaching powder or potassium permanganate a strong solution may be added to the container. The stool or urine should remain in contact with the disinfectant for at least one hour before disposing of it in a latrine, or in a pit two feet deep and at least 100 feet from the well. Eating utensils, clothing and bedding should be boiled

after each use. Water used to bathe the patient must also be buried. The thermometer may be kept in spirit or another disinfectant.

The prevention of typhoid fever means cleanliness, clean food, including water and milk, and cleanliness of person and environment. For India, the inventor of the septic tank latrine and modern plumbing, it is a matter of regaining lost arts and putting meaning in to present ritual.

CHAPTER II

DIARRHŒA

Diarrhea is a symptom of several common, preventable diseases in village India. The three most important are cholera, bacillary dysentery and amebic dysentery.

The most severe of the diarrheal diseases is cholera. Cholera is caused by a bacterium called the comma bacillus, because of its curved shape. Cholera is primarily a disease of India. Over 90% of deaths due to this disease occur here. It is not unusual for over 5 lakhs of people to die of cholera in a year. About 50% of patients with cholera, die of the disease, although proper treatment may lower this figure considerably.

The disease is characterized by severe diarrhea starting about 3 days after accidentally swallowing the bacteria. The stools resemble rice water. The symptoms are caused by a poison liberated from the bacteria. So much fluid is lost from the body, there is little left for circulating blood. The patient generally dies in a few days without even developing fever. Recovery may start after about 4 days and fever develops then. There is no specific medicine to cure cholera. Replacement of lost fluid by intravenous salt solutions will give the patient a good chance to survive.

Cholera epidemics are caused by drinking water contaminated with stool or urine of cholera patients or carriers.

Between epidemics, occasional cases appear which may be spread by flies, fingers, food and all other channels from the anus of one man to the mouth of another as described for typhoid fever. Control measures are therefore similar to those of typhoid fever, being centered about isolation, chlorination of water, the proper use of latrines, fly control and personal cleanliness. Inoculations give a fair degree of immunity for about 6 months. The injections can be combined with those for typhoid protection.

Bacillary dysentery is the most common cause of severe diarrhea. The disease is most dangerous for infants and children as they lose a greater percentage of their body fluid. Diarrhea is the most common cause of death among infants in India. Bacillary dysentery is caused by a group of bacteria known as the dysentery bacilli.

Symptoms appear a few days after swallowing the bacteria. They are due to two poisons produced by the bacteria, one affecting the nervous system and the other the intestines. Headache and a general feeling of ill-being are due to the nerve poison. The diarrhea is an attempt to get rid of the bacteria and its intestinal poison. The intestines become irritable and move faster. The lining of the intestines produces larger amounts of mucus. Frequently the intestinal poison injures the intestinal lining enough to cause bleeding, and blood appears in the stool. As the poisons and bacteria are absorbed into the blood stream, fever is produced. In the intestines the bacteria multiply to enormous numbers and become available in the patient's stool to infect others.

Contamination of food is probably the most important method of spread, either by flies or by people handling food, Most outbreaks of diarrhea in institutions, are due

to bacillary dysentery. All the processes described for typhoid fever by which stool or urine is accidentally swallowed, are at work in the spread of this disease. Methods of control are, therefore, similar. The disease rarely occurs in clean communities.

Bacillary dysentery is a self-limited disease. Recovery generally comes in a few days without treatment, but leaves the patient in a weakened condition. The patient will be helped by proper diet. This should be such as to give maximum rest to the digestive system. The most complete rest is obtained by fasting, taking only water by mouth. This is advisable for one day. Easily digested liquids such as buttermilk or rice water should then be given in small feedings. As the number of stools per day decrease, soft rice and curds may be added. Fatty foods, including breast milk, will make the condition worse. The advice of a doctor should be sought.

Amebic dysentery is caused by a one-celled animal called *Entameba hystolytica.* Although several times larger than bacteria it cannot be seen without the aid of a microscope. In contrast to bacillary dysentary which is a severe disease of short duration, amebic dysentery usually starts with mild diarrhea but tends to recur. There is usually little fever, but blood is frequently present in the stool.

The ameba lives in the large intestines in two forms. The trophozoite is motile and capable of damaging the intestinal wall. It causes the symptoms of the disease. When passed in the stool it soon dies. If accidentally swallowed by another person it is generally destroyed in the stomach. The other form is the cyst which has a protective cover. It produces no lesions but serves to infect others. A person who has once had amebic dysentery, may be

a carrier of these cysts for many years without symptoms of the disease. It is through these carriers, that the disease is spread. A carrier who handles food for others' is a particular menace. But the disease is spread by all the methods described for typhoid fever. Control measures are also similar. Treatment can only be adequately done by a doctor.

CHAPTER III

WORM INFECTIONS

There are four different worms that commonly live as parasites of man in India. Each is spread by eating or stepping on infected material. They do not occur where people use latrines and protect or purify their drinking water. The life cycle of each worm is different and all are most interesting.

Pinworm *(Enterobius vermicularia)*, is an infection of intestines. The worms are about a centimeter long and can frequently be found at the anus where they cause severe itch. Children are most frequently infected.

The eggs are laid at the anus and contaminate the stool as it is passed. The eggs are swallowed by another person on contaminated food, drink or fingers. The eggs hateh to a worm in the intestines of the new host. The worm holds on to the wall of the intestines where eggs in the female worm are fertilized and develop. When the eggs are ready to be laid, the worm relaxes its hold on the intestinal wall and passes through the anus. Here the eggs are again laid. The cycle is completed in two weeks.

Another common worm infection is caused by round-worm, *Ascaris lumbricoides*. The adult worm is white, round and about 30 centimeters in length. It lives in the intestines and its eggs are passed with the stool.

Each female worm lays about two lakhs of eggs a day. These are swallowed by another person in the same way as pinworm or the diarrheal diseases are spread. The eggs hatch in the intestines of the new host as small worms called larvae. These larvae penetrate the wall of the intestines and enter the blood stream. In the blood the larvae are carried to the lungs where they break through the tiny air sacs and proceed up the trachea. As they reach the throat they are swallowed, entering the digestive system once again. In the intestines they grow to adult size and remain for about six months, daily laying their eggs which become available in the stool, to infect others.

As the larvae migrate through the lungs they may cause cough and high fever. The adult worms in the intestines cause vomiting, abdominal cramps and diarrhea. The worms occasionally pass out with the stool. The eggs can always be seen in the stool, with the aid of a microscope.

Hookworm, *Ancylostoma duodenale*, is a third common worm spread by stool. The adult is about one centimeter in length and lives in the intestines where eggs are laid and passed with the stool. The disease may spread by the eggs being swallowed by another person, but generally a different route is used. The eggs develop in the earth under suitable conditions to small larvae. These larvae have the ability to penetrate the skin of anyone who happens to walk barefooted on contaminated soil. In as much as most of our villagers do not use chappals and the roadside is frequently used as a latrine, it is not surprising that hookworm infection is common in many of our villages. The larvae enter the blood stream and are carried to the lungs. There they break through the

air sacs and travel up the trachea to be swallowed upon reaching the throat. In the intestines the larvae mature to adult worms, the female of which lays numerous eggs that contaminate the ground with the stool.

In the intestines the worms attach to the intestinal wall and suck blood, which is their food. Each worm may take about ten drops of blood per day. It is not unusual for thousands of worms to be present. Thus the main symptoms of the disease are related to anemia. Common symptoms are weakness, pallor, rapid pulse, digestive difficulties, and mental and physical retardation in children. The eggs may be found in the stool with the aid of a microscope.

A fourth worm infection is caused by the guinea worm, *Dracunculus medinensis*. This worm lives as an adult in the deep tissues of the extremities, usually the leg. They are round, thin and about a meter in length. The disease is common in those parts of India having stepwells.

When the adult worm is ready to expel her larvae, she migrates to the skin of the leg where a blister is formed that eventually ruptures. If the foot is then placed in water, as in a well having steps to the water level, the worm liberates many larvae into the water. These larvae are eaten by a small insect in which they undergo further development. If this water is then taken into the mouth these small insects will be swallowed and the larvae are released in the intestines to migrate through the tissues where they develop to adults in about 8 months. The ritual of washing the mouth, so common in India, makes this and many other infections more easily contracted. It also helps spread disease. It adds nothing to

the health or cleanliness of the person, as one quart of saliva each day adequately cleanses the mouth.

The prevention of this disease involves protecting the water supply. Water should be removed from wells by bucket or pump. If this is not possible the well should be disinfected regularly or stocked with small fish that eat the insects which serve as intermediate hosts for the worm.

The treatment of all worm infections is best done by a doctor. All effective medicines for their treatment are dangerous. It is another case of "better to prevent than cure".

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CHAPTER IV

WATER

Water is a prime necessity of life, not only for diet but for personal cleanliness. Pure water is a chemical curiosity not found in nature. Water is a good solvent and takes on impurities readily, including gases, liquids and solids. Water may contain many bacteria and is a frequent medium for the transmission of infection.

Water may be classified as clean, polluted or contaminated. Clean water is free from contamination and safe for human consumption as determined by laboratory tests and experience. Polluted water is impaired by addition of substances causing turbidity, colour, odor or taste. Contaminated water contains human or animal wastes or chemical poisons.

There are three sources of water in nature, rain water, surface water and ground water. Rain water collected from a clean surface in the country is the purest of natural waters. If it is to be used for drinking purposes, care must be taken in collecting it to avoid pollution or contamination. Rain water is also desirable for laundry and cooking. It is economical to collect and easy to avoid contamination, especially in above ground containers.

Surface water includes rivers, lakes and reservoirs. Because this water rests on the ground, it is easily polluted and contaminated. It is hardly practical to prevent conta-

mination of surface water. It is more economical to treat the water taken, for use, from surface waters.

Ground water includes wells and springs. In general it is safer than the surface water, from which it came. Surface water is greatly purified as it filters through soil to ground water level. Organic matter is oxidized and bacteria are largely strained out. Minerals are taken up making ground water harder than surface water. The amount of ground water depends upon the rainfall, evaporation from the surface, vegetation and amount of storage space in the pores of soil.

A well is nothing more or less than a hole sunk into the earth to reach a supply of water and fitted with some mechanical arrangement for lifting the water to the surface. Wells may be shallow or deep, dug, drilled or driven. Shallow wells are dug and lined with stone or brickwork. They are usually 5 or 6 feet in diameter and rarely over 30 feet deep. Driven wells are made by driving an iron pipe into sandy or gravelly soil. The iron pipe is fitted with a perforated strainer, pointed at the end and covered with screening so as to allow entrance of the water and to exclude the sand and gravel. By deep wells are meant drilled or the so-called artesian wells. They consist of an iron pipe or tube 6 to 8 inches in diameter, and may extend many hundred feet into the earth. If the water is drawn from a depth of one hundred feet or more without passing an impervious stratum, the well is usually spoken of as a deep well. If the well passes an impervious stratum to reach water resting upon another impervious stratum, it is spoken of as an artesian well.

The filtering power of the soil is usually sufficient to protect the water drawn from a well, unless (1) the soil

is over-burdened with organic matter, or (2) a defective latrine is nearby or (3) fissures exist in the soil so that impurities reach the well without undergoing the process of biologic filtration.

In locating a well much depends upon the surface configuration of the ground, the character of the soil, and the proximity of possible sources of pollution. The casing of a dug well should be water tight, preferably of brick

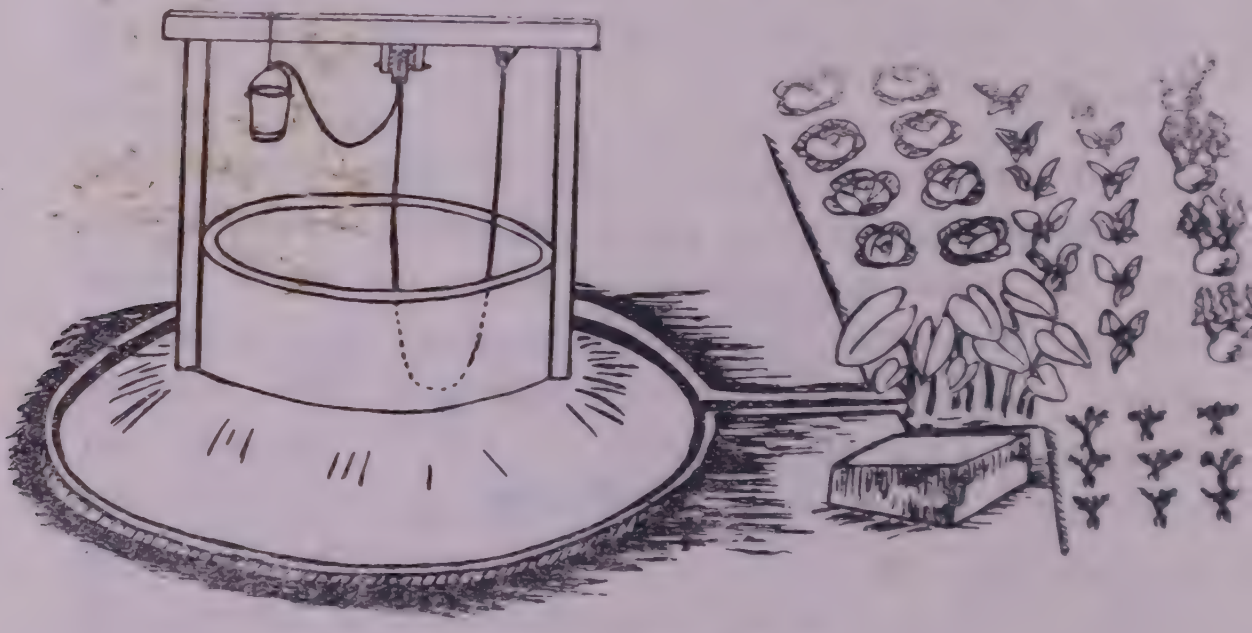


Fig. 1. Open Well

laid in cement mortar, pointed on the inside. This impervious casing should extend as deeply into the well as practicable, and after it is laid the outer space between the casing and the earth should be filled in with clay soil or concrete. The casing should extend at least 18 inches above the surface of the ground. Ideally the well should be covered and a pump used to raise the water. In this way contamination from things dropped into the well is eliminated. If buckets must be used the bucket should remain at the well.

A person's foot should never rest on the inner lining of the well.

Wells should be located on an elevated area and the surrounding ground kept clean and turfed. Waste water should be drained, to a garden.

The same precautions should be taken for deep wells although they furnish one of the safest sources of water.

Recently Dr. Abbott designed a safe covered well at Barpali, Orissa. It consists of a reservoir of water at the bottom of the well with a 6 inch brick or cement pipe

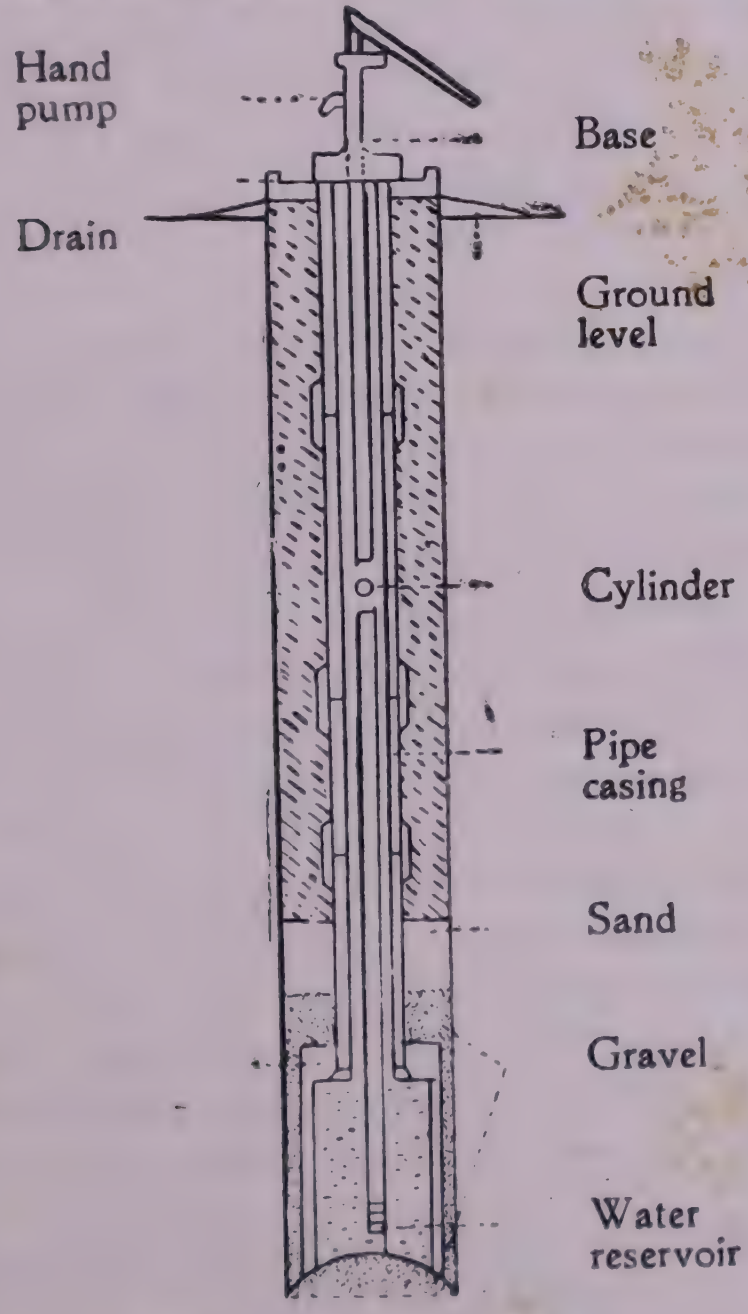


Fig. 2. Barpali Well

opening to the top. Excavated earth is replaced over the reservoir and a hand pump installed on top with the pipe leading to the reservoir. As this construction requires less masonry than the open well, its cost is generally less. It is certainly safer. *

It is most essential that each village have at least one covered well for drinking water. The savings to the community in work-time lost and medicines will easily pay for covering one well and installing pumps. Those villages having electricity should consider an electric pump with tank and distribution systems. There is always a close correlation between availability of clean water and good health.

The main purpose of purification of water is to remove bacteria causing water-borne diseases. A secondary purpose is to make the water more appealing by reducing turbidity, colour, odors and taste. The method of purification must be economical. In nature water is purified by various methods, the chief of which are : (a) evaporation and condensation, which makes rain the purest of natural waters; (b) the self-purification of running streams; (c) storage and (d) physical, chemical and biologic action of the soil.

Artificial methods are not always applicable to the village. The purest water is distilled water but is unnecessarily expensive. Boiling is one of the safest methods of purifying water, but is somewhat expensive. Artificial filters are too difficult to operate in a village at this time. Storage of water is one of the simplest and best means

* For additional information on wells and pumps write to-
Barpali Village Service
P. O. Barpali, Distt. Sambalpur, Orissa.

of purifying it. The initial cost is high but maintenance low. Bacteria soon die, organic matter is oxidized and solids settle out.

Chlorination is one of the cheapest and safest methods for disinfecting water. One part of chlorine per million parts of water will render the water safe to drink. Chlorination of drinking water only is cheaper and safer than chlorinating the source of the water, as a well or reservoir. The quantity to be chlorinated is less as well as the chances of recontamination after chlorination. A convenient method is to make a strong chlorine solution from bleaching powder. About ½ teaspoonful in 12 ounce brown glass bottles, such as are available from the Veterinary Surgeon, will give a useful concentration. One teaspoonful of this solution will purify an ordinary pail or earthen-ware pot of water. It is best to wait 20 minutes to allow the chlorine to act.

Uufortunately bleaching powder is unstable when exposed to air, the valuable chlorine gas being continuously lost. The solution is stable for long periods. There is a simple test to determine whether or not the purified water actually contains one part chlorine per million parts of water. Chlorine is capable of changing an iodide salt such as potassium iodide into iodine. Iodine is brown in colour, but this colour will not be produced by small concentrations of chlorine such as one part per million. However, some iodine is formed. Enough is formed to change fresh starch faintly blue. The procedure then is to try ½ teaspoonful of fresh bleaching powder in 12 ounces of water which is a strong, stable chlorine solution. One teaspoonful of this chlorine solution is added to an earthen-ware waterpot. To a glassful of this treated water is added one small crystal of potassium iodide and a few drops of freshly

prepared starch solution. Rice water will do. The water should turn sky blue. If it turns dark blue too much bleaching powder was used. If no colour developes, more bleaching powder is needed. By this method a family can be provided with a safe supply of drinking water for about 1 anna a year and be reasonably sure of being free of typhoid fever, worms and diarrhœa.

Disinfections of wells is helpful but not nearly as reliable as disinfection of drinking water. It is also more costly. Each 1000 gallons of water in the well requires ½ ounce of fresh bleaching powder. A simple formula for determining approximately the number of gallons of water in the well is :

$D^2 \times W \times 5$ = Gallons of water in the well, where D is the diameter and W the depth of water in the well measured in feet.

CHAPTER V

THE FLY

The common house fly, *Musca domestica*, because of its habits, spreads an immense number of micro-organisms of which the average fly carries one million. There is definite proof for the transmission of 30 different diseases among which are most of India's worst, cholera, typhoid, amebic and bacillary dysentery and tuberculosis.

The transmission of germs of these diseases is mechanical in nature and occurs in at least four ways :

(1) By the hairs of the flies' legs;

(2) By feces, the organisms having passed through the intestines of the fly;

(3) By vomitus, it being habitual with flies to regurgitate a portion of their food.

(4) By metamorphosis, organisms taken up by the larval forms being not infrequently present in the body of the adult fly.

The habits and life history of the fly give the clues for its control. The eggs of the fly are deposited in manure, garbage or any moist warm organic material. A single fly may lay about 2000 eggs which are capable of hatching in 8 to 24 hours. Generally only a small percentage find conditions suitable. Once hatched the maggots will not develope if the temperature is too hot,

as in the center of a manure pile, neither can they survive if the medium becomes too dry, as in manure spread thinly upon an open field.

In three to six days the maggot becomes a fly and in another 2 days the new fly is already laying eggs. In this way the fly population grows to enormous numbers at an increasing rate. If measures are to be taken to control breeding they should be taken early in the season.

The flies normally migrate but little from their place of origin although they are capable of travelling up to 14 miles. The extent to which the fly population is contaminated depends upon the level of sanitation in the area. In regions where human feces are deposited directly upon the ground, there is heavy contamination of flies both externally and internally with infective organisms the human population may be carrying.

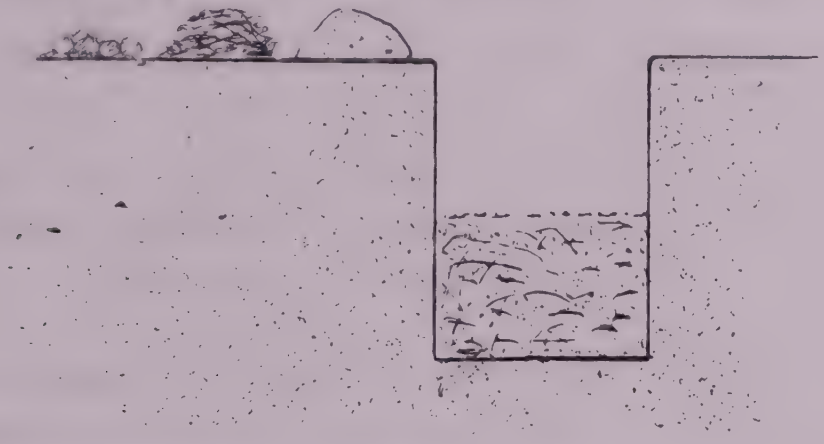
In the act of feeding the fly at first regurgitates part of the contents of its crop. The vomitus helps dissolve the food of the fly which must be drawn through a very narrow opening to the fly's stomach. Human food may thus become inoculated with dangerous organisms, especially if the fly has recently fed on human stool. the fly may also defecate while feeding and again contaminate our food.

The bacteria of bacillary dysentery remain alive in the intestines of a fly for 4 days and the cysts of *Endameba hystolytica* for 2 days.

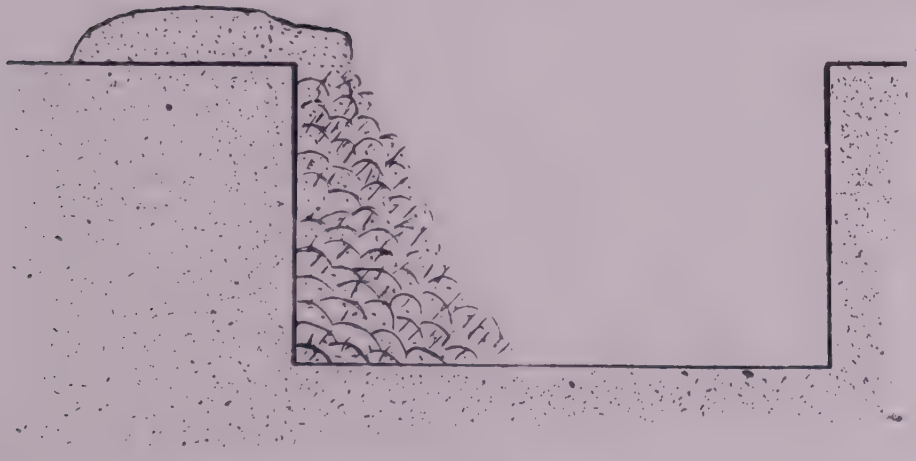
There are two important principles of fly control. The first is to begin work early in the season, before the fly population is large. The second is to concentrate on prevention of breeding rather than on destruction of the adult fly.

The elimination of fly breading areas involves three

separate problems. The first is the disposal of animal manure. The cow and bullock sheds should be so constructed as to make daily cleaning easy. The manure may be spread daily in a thin layer on an agricultural field. Or it may be stored in a pit or pile above ground. The method of filling the pit or building the pile is most important.



Mixing Method



Covering Method

Fig. 3 Compost Pits

The best method is to mix the dung well with grass and earth. This breaks the dung up into small pieces and flies are unable to breed in it. The temperature of such piles and pits is very high and good compost produced in a short time. When grass or weeds are not available, the dung

should be deposited on a pit in such a way that the first day's dung is buried by the second, third and fourth. With this method the developing larvae die. The top of the pit should be covered with four inches of earth or compost.

The second problem in prevention of fly breeding is the disposal of human excrement. In the trench latrine this means completely covering each stool with earth before flies can reach it. In the rainy season large amounts of grass must also be used. If the field is used the same applies. This is not only important to prevent breeding of flies but also for the prevention of contamination by flies.

Finally there is the problem of disposal of garbage. For temporary storage of garbage water-tight containers with well-fitted covers should be used. Ultimate disposal should be in a compost pit. These pits must be so managed that no organic material is left exposed to the air. After each dumping of garbage a layer of earth is added to shield it from flies, or a cover must be fitted over the pit.

On the plains of India there are three times in the year when fly breeding is particularly apt to occur. The first is early in the rains when there is moisture and warmth. During the rains breeding may decline due to drowning of many larvae. Just after the rains is the second time it is moist and warm. Soon it becomes cooler and breeding proceeds at a slower rate. Again as the weather warms up and there is still considerable moisture from the rains a third period of rapid breeding may occur. As the temperature rises still higher there is a tendency for breeding places to become dried out and the pace is again slowed.

In spite of the most conscientious efforts to prevent breeding of flies some will attain maturity. Also the flight

distance of the fly is such that adult flies may enter the community from distant sources not under your control. This is not an important factor in a clean community, as there will be little to attract the flies in the first place.

Screens are useful in excluding flies from areas where food is prepared or eaten. If the type of latrine used can not be made fly-proof, it should also be screened. This is just one more effort to break the stool to mouth cycle. Screened-in cupboards are useful in the kitchen to store foods likely to attract flies. If metalic or plastic screen is used, 14 wires to the inch will exclude house flies, but it is still better to use 18 mesh to exclude smaller insects at the same time, especially if the place is being used after sunset. If bamboo is used the strips should be narrow to admit as much light as possible. Fly swatters and sticking paper are useful within screened rooms.

A significant reduction in fly population can be effected through fly traps. A conical type made of screen and baited with waste fruit, works very well. The flies enter from below and as a result of their tendency to fly upward toward the light, pass through the narrow aperture at the apex of the cone into an upper chamber from which they are unable to escape. These traps function best in the sun, in a place protected from wind. It is essential to their effectiveness that no uncovered garbage, manure or human excreta be in the area to compete with the bait.

Sprays such as DDT and other chemicals are expensive and give very temporary relief. Where preventative measures break down this method is useful in giving the community a second chance at preventative control which they missed earlier in the season.

Individual efforts to control the fly population are ineffective unless the entire community is prepared to cooperate. A single neglected breeding place can nullify an otherwise excellent program.

CHAPTER VI

THE SOIL

Countless millions of bacteria occur in the upper few inches of soil. This enormous overgrowth of bacteria gives rich soil its sticky moist feeling. Even the odor of soil after a rain is largely due to certain bacteria. But few bacteria are found below a depth of four to six feet in undisturbed soil.

Most of these bacteria do not cause disease. The bacteria causing epidemics do not find conditions favourable for growth and multiplication in the soil. Generally the temperature is too low; the food in the soil too meager; further they are crowded out by the overgrowth of soil life. The soil does contain the bacteria of certain wound infections, among which is tetanus. Hook worms and certain other animal parasites spend part of their life cycle in the soil.

The soil, through the action of its harmless bacteria, is capable of disposing of great quantities of organic matter. However, if it receives more organic matter than it can dispose of it becomes polluted and may endanger health through contamination of drinking water. It is not only the amount but the kind of pollution, and also the manner of disposal that plays an important part. It must first of all be remembered that the purifying action of the soil is largely dependent upon bacteria, and that

this action takes place almost solely in the upper layers. If carcasses are buried deeply, or if sewage enters the soil far below the surface, the process of purification is long delayed or checked. A leaky latrine which discharges its contents into the soil at a depth of five feet or more may seriously pollute the ground water, whereas the same material placed just beneath the surface may be entirely purified before it reaches the depth of five feet. The main factors inhibiting all bacteria at such a depth are the low temperature, lack of moisture and lack of oxygen.

All polluted soils are not equally dangerous. Soils polluted with human feces and urine present the greatest hazard to man. The special menace of soils polluted with human excreta is from hook worm, as this parasite enters the body directly through the foot. The danger in the case of typhoid, dysentery, cholera and other bacterial infections is usually indirectly through contamination of drinking water or through flies or other mechanical means of transference. A soil polluted with typhoid may endanger either the surface water or the ground water. Yet if the feces and urine of a typhoid patient is disposed of in a properly constructed and properly used latrine, the soil soon purifies it. Hard soils with fissures present an extra hazard as the contamination can reach the ground water more readily.

There is another way in which the soil can be our great friend, which is closely related to the problem of disposal of excreta. The soil has the power to convert animal and human wastes into substances needed for the growth of plant life. The most important of these substances is nitrogen. The process is known as the nitrogen cycle. A knowledge of this cycle is essential to a clear conception of soil pollution, water purification and sewage disposl.

The nitrogen cycle is a complex series of chemical reactions through which the nitrogen of animal protein, which is abundant in animal wastes, is converted to plant protein which in turn is available to nourish the bodies of man and animals. One phase of the cycle, the breaking down of protein, is due almost entirely to bacterial action. The other phase, namely the building up of complex living organic matter from simpler compounds and elements, is mainly a function of living plants. Any permanent break in this cycle would result in the cessation of life upon the earth. The supply of nitrogen in the form of organic matter is very limited. Fortunately the supply in the air is abundant and certain bacteria in the soil are capable of using atmospheric nitrogen for energy and at the same time convert it to a form that can be used by plants.

As soon as an animal or plant dies its protein constituents are at once attacked by putrefactive bacteria whose job it is to break up protein to simpler substances. Many of these bacteria are anaerobes, that is, they grow best in the absence of oxygen. In this process the protein is also liquified. For the most part the bacteria capable of producing disease in man are killed during the process of putrefaction; they die in the struggle for existence with the soil bacteria.

All matter is composed of very small particles which are too small to be seen with the ordinary microscope. These are called molecules. In the case of protein the structure of its molecules is exceedingly complex. More so than any other matter. These complex protein molecules are broken down by the soil bacteria to simple parts, until the main product is carbon dioxide and ammonia. This process is called mineralization Most of the carbon dioxide

passes into the atmosphere. How it gets back into plant life will be discussed later. The ammonia contains the all-important nitrogen without which plants will not grow. Ammonia as such cannot be used by plants. Some of it escapes into the atmosphere but most is retained in the soil. In the soil bacteria add oxygen to the nitrogen of the ammonia to form nitrites and nitrates. These nitrates can be readily taken up by plants and utilized to form plant protein. Men and animals are not capable of producing the necessary protein for their own bodies from ammonia or nitrates. They must depend upon the protein of plants or other animals.

While protein molecules are complex structures containing nitrogen as well as carbon and water, carbohydrates are made up of simpler molecules containing only carbon and water. The conversion of carbon from the carbohydrate of dead plants and animals or the wastes of animals to carbon of living plants is known as the carbon cycle. We have already described the breakdown of protein ending in carbon dioxide. But this accounts for only a small part of the carbon necessary for plants. Most of the carbon comes from carbohydrate. The breakdown process is similar to that of proteins (mineralization) but is done by different bacteria producing first alcohol and finally carbon dioxide which is released into the atmosphere. This process is called fermentation. The carbon dioxide so produced unites with water in plant life and in the presence of chlorophyl and sunlight is again built up to carbohydrates in the form of starch, sugars and cellulose.

The soil is a living thing and the greatest resource of any agricultural country. Unfortunately, it has not been treated in the past with the respect it deserves. This error is the main reason for India's poverty.

The problem is known as soil erosion, and is strictly man's own doing. Before the coming of man the land was protected with a covering of grass, shrubs and trees. These in themselves have a tremendous capacity of holding water. In addition, as they die, they add organic matter to the top soil, which acts as a huge sponge. When man cuts the forest and ploughs the meadows, he may start a chain of events leading to tragedy. The soil no longer holds the water, the heavy rains form erosion gullies through which the valuable top soil passes to the ocean, causing floods on the way. During the hot season, it is impossible to grow crops on the parched subsoil that remains, and the dust storms caused by uncultivated, grassless areas carry additional tons of soil to the sea. As time goes on there is less tendency for rain to fall on the hot plains, as the clouds are no longer cooled by vegetation below.

Certain steps must be taken if this process is to be reversed and our soil restored to a point where it can support a healthy human and animal population. It is a matter of imitating nature – a nature cure for the sick soils of India. First, the trees, especially on the hills and slopes, must be replanted. In this way the subsoil water will be held and slowly released in the hot season to the land below. Second, the fields must be terraced and bunded and the bunds lined with trees to hold the top soil in place. Third, erosion gullies must be given a gentle slope and a covering of grass, shrubs and trees. This will slow the rate of flow and thus check the progression of the gully and prevent the top soil from being carried away. Finally, the minerals and organic materials must be replaced by good methods of composting and crop rotation.

Nature's method of composting forms a rich black crumbly humus from the decomposition of leaves and

animal wastes. Humus can be found in every forest. It contains billions of bacteria anxious to help living plants. Humus is also the end product of good composting.

Good compost can be made in either piles or pits. Piles are preferable in the rains and pits in the hot season. All available organic material should be utilized in the compost. An attempt should be made to mix the ingredients of the compost so that the ratio of nitrogen to carbon is about 1 to 10. * This will give the most rapid decomposition and best humus formation. Also there will be less likelihood of fly breeding.

Thus, if the nitrogen/carbon ratio of night soil (1/2-7) composted in a trench latrine is lowered to 1/6.1 by the addition of earth covering weighing twice that of the night soil, the mixture will require an equal weight of green grass to bring the nitrogen/carbon ratio to approximately 1/10. (average of 1/6.1 and 1/13, or 1/9-5)

The composting of human stool and urine in a safe latrine is of the greatest importance both from the point of view of health and for the economy of the country. The average person passes 150 lbs. of stool per year. With a population of 350,000,000 this comes to 31,000,000 tons. If only 20,000,000 tons were composted with grass and earth, it would give about 40,000,000 tons of humus per year. The value of this compost at Rs. 3 per ton would be 12 crores Rs. and would go a long way towards inproving our soil.

* See Appendix Table 1.

CHAPTER VII

LATRINES

The latrine of village India is the field and roadside. The result of this practice is heavy contamination of the fly population, earth and water supplies with bacteria and parasites capable of causing serious illness. It is not unusual for one person to use a stream as a latrine and another as a source of drinking water, a short distance down stream. As a result the diarrheal diseases are so common in our villages as to be thought of as an inevitable and normal part of living. The problem is one of education. If the field were used as a latrine and the stool covered with earth after each use, the problem would be solved. Many special structures have been devised to make the disposal of excreta more convenient and safe, but none, to date, have found wide favor in our villages. Those that are most convenient and most safe, are also most expensive. The inexpensive latrine is difficult to maintain properly. We shall describe the various latrines used in the past and suggest new designs that may be better suited to the needs of our villages.

1. The Surface Latrine (Fig. 4)

The simplest latrine is the surface latrine. This consists of a latrine house with a hole in the floor to form a squat plate. The stool falls to the ground and is immediately covered with earth. A square form about the pile of excreta will make covering the stool easier. The latrine may be fly proof. The main disadvantage is the large amount of earth required to cover the stool adequately.

This is even more difficult in the rains. There will generally be some odor unless it is very well cared for. The addition

Fig. 4

of green grass and leaves acts as a deodorant. There is always the danger of fly breeding.

2. The Trench Latrine (Fig. 5)

The trench latrine is similar to the surface latrine

Fig. 5

except that the stool falls into a trench about 18 inches wide and 2 feet deep. It produces better manure than

the surface latrine but it has all of its disadvantages plus the necessity of digging a trench and the fact that it cannot be made fly proof. In spite of this it is a safe latrine if diligently cared for.

3. The Pit Latrine (Fig. 6)

The pit latrine is similar to the trench latrine but about 5 feet deep. It may be made fly proof. It does

Fig. 6

not require emptying as often as the trench latrine, but it makes a poorer grade of manure and unless made pucca, is likely to contaminate wells in the area.

4. The Bore Hole Latrine (Fig. 7)

The bore hole latrine is essentially a narrow well used as a latrine. It is expensive to construct and very

dangerous in any area using shallow wells for drinking purposes. Once built it lasts for many years with little

Fig. 7

care. The nitrogen so badly needed to fertilize the soil is lost.

5. The Pail Latrine (Fig. 8)

The pail or commode latrine is rarely successful without a sweeper service. It adds an extra procedure to

Fig. 8

the problem–emptying and cleaning the pail. It is useful as a bedside latrine for the sick.

6. The Chemical Latrine (Fig. 9)

A chemical latrine is essentially a closed container

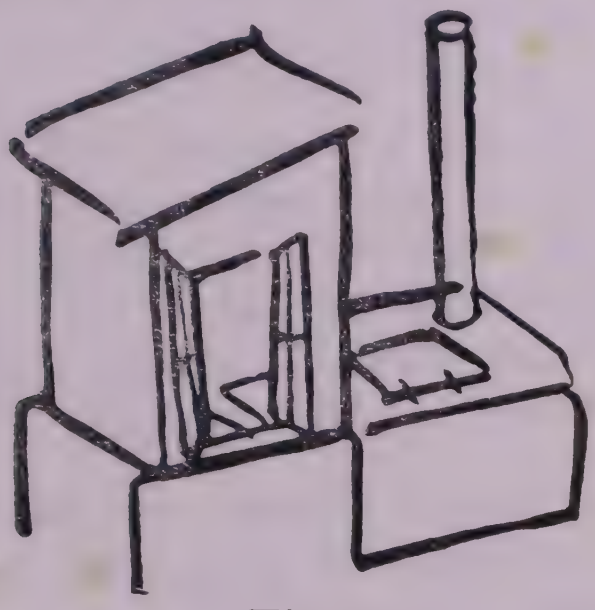


Fig. 9

containing a strong disinfectant. It is safe and convenient but expensive to operate and gives no manure.

7. The Septic Tank Latrine (Fig. 10)

The septic tank latrine is the safest and most convenient latrine suited to country conditions. Unfor-

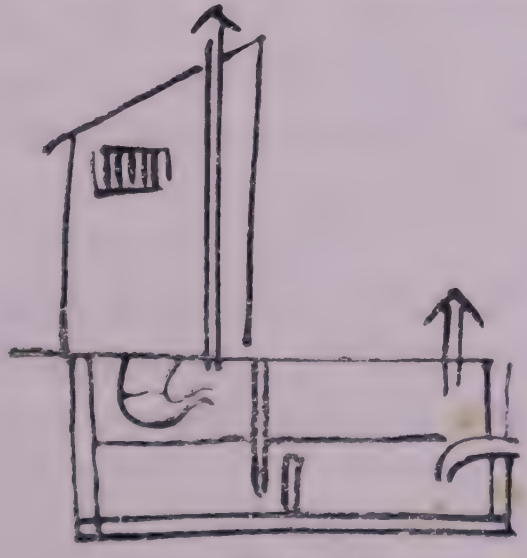


Fig. 10

tunately it is also the most expensive to construct. Still a village should be able to build such a latrine for use as

a public latrine. Few could afford it as a family latrine. The latrine consists of a large water-tight tank which is partly divided in two or more chambers by a baffle. Little oxygen enters the first chamber where the excreta enters. Here anaerobic bacteria liquify the stool and start the breakdown of proteins. The contents of the first chamber slowly move under the baffle to the second chamber which is exposed to air. Here the aerobic bacteria complete the breakdown of proteins to nitrates and the fluid leaves the second chamber ready to fertilize a nearby orchard. Almost all dangerous bacteria have been destroyed.

The latrine floor is generally also the top of the tank. Gases and odors from the tank are prevented from entering the latrine house by a water seal. These gases escape through a tall pipe that admits little oxygen. The most common and safest type of seal consists of a U-shaped tube where water is always present and serves as a seal preventing any air from passing. Alternately the seal may consist of a pipe extending from the squat seat into the liquid in the tank. This is called an aqua privy. The former is somewhat safer and cleaner but requires a full bucket of water to flush the stool through the seal. Few villagers are prepared to take this precaution today.

None of the above latrines is ideally suited to the conditions of our villages. If a village family latrine is to become popular in village India today, it must be :

(1) Cheap,

(2) Easily made in the village,

(3) Economical to maintain,

(4) Safe :

a. No contamination of flies,
b. No contamination of water,
c. No breeding of flies.

(5) Convenient :

a. Easy to clean,
b. Capable of being flushed with the small amount of water used for ablution,
c. Needing little digging,
d. Needing no dirt covering,
e. Odorless.

(6) Capable of producing manure.

8. Pit Latrine with Sevagram Seal

A latrine meeting these requirements is a shallow pit latrine equiped with the Sevagram Seal (Fig. 11). This seal

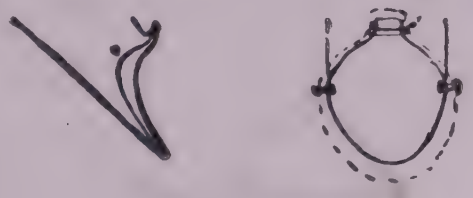


Fig. 11

consists of a 4 inch pipe the end of which is cut curved like an open fish mouth. This is covered with a flap of rubber from an old truck tire tube. The pipe is attached to a funnel shaped bowl in line with its lower surface which is at a 45 degree angle with the latrine floor.

This unit is easily made of galvanized metal. It may be conveniently installed in a fly-proof box 6 inches high and 2½ feet square. The box with seal is placed over a pit about 2 feet square and not over 3 feet deep. Deeper pits may contaminate wells in the area and even shallow pits should be at least 100 feet from the well. An all

galvanized metal box (Fig. 12) has been most popular with villagers in our area. This may be installed in a small

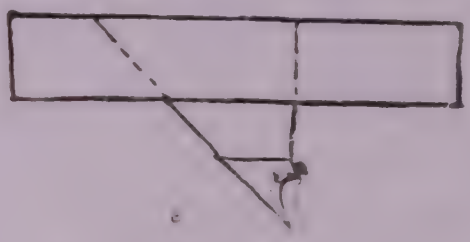


Fig. 12
Metal Box Latrine

compound protected by palm mats or mud walls large enough for two pits. After three months the seal is shifted to the second pit and the old pit closed with a covering of grass and earth. In another three months this will be mature manure and can be safely dug out and used to fertilize a field. In this way two pits should suffice for a family of six. Larger families will probably need a third pit.

The same box can be installed under a latrine house of wood and bamboo mat. Or the seal may be installed

Fig. 13
Seal in Latrine Floor

in the floor of the latrine (Fig. 13) and the lower part of the latrine made fly proof. Alternately, the tube may be

made 2 feet in length so as to extend outside the latrine into a pit on one side of the latrine (Fig. 14). If this

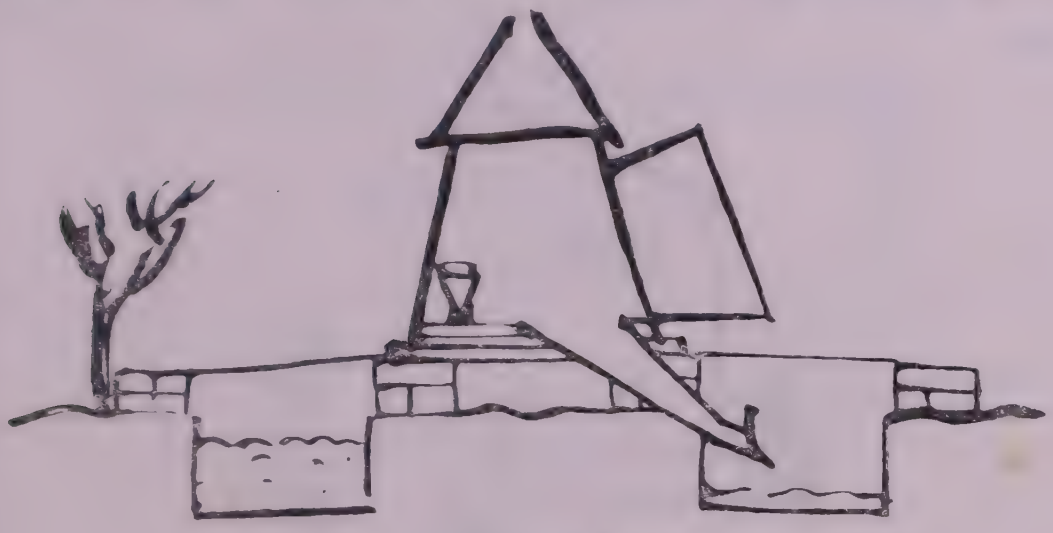


Fig. 14

Seal with Side Tube

version of the seal is mounted into the central section of the floor the entire unit may be turned every three months to one of the two pits on each side of the latrine. The pit requires a fly proof cover, but the floor need not be fly proof in this model.

Finally, the unit may be installed in a pucca latrine house, (Fig. 15) the bowl being of cement and the tube of 4 inch china tile with a short seal on the end leading to a pit outside the house. The pit may be divided in two by brick wall and each side used alternately for three months.

The success of this latrine depends upon several factors :

1. A tight seal. A rubber flap has proved satisfactory. Minimum resistance by the flap means minimum water to flush the seal.

2. A shallow kutcha pit. The abundant bacteria in the top layers of the soil assure a rapid decomposition of the excreta and therefore good manure and minimum odor.

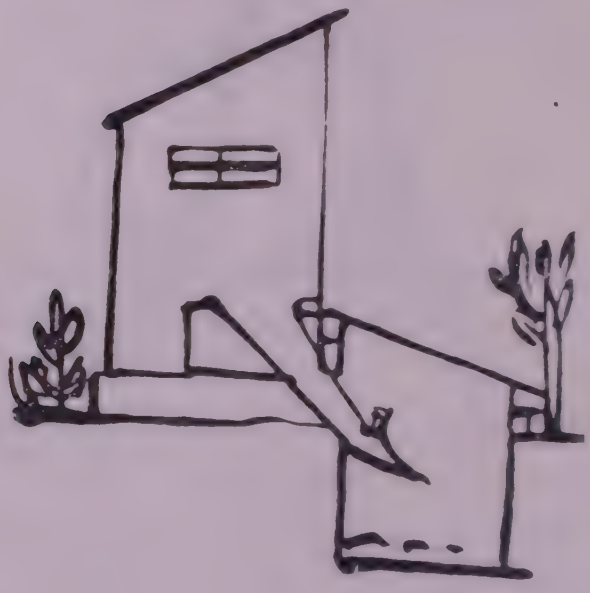


Fig. 15
Pucca Latrine with Seal

3. A steep angle and smooth surface. This assures easy cleaning. The pit works well in black soil or sand but tends to collect water in *murum* due to lack of seepage.

In such cases abundant grass should be added to the pit and the pit changed more frequently. All new compost latrines should be started with the addition of a small amount of compost to the pit.

9. Junior Aqua Privy (Fig. 16)

The expense of an aqua privy latrine can be reduced by making the tank in one small chamber or substituting a large earthen vessel and leading the fluid alternately to two compost pits every three months. (Fig. 16) This junior aqua privy can be made by the village potter. The pit

should not be over 3 feet deep but may be as long as necessary to last 3 months. Stone slabs make an ideal

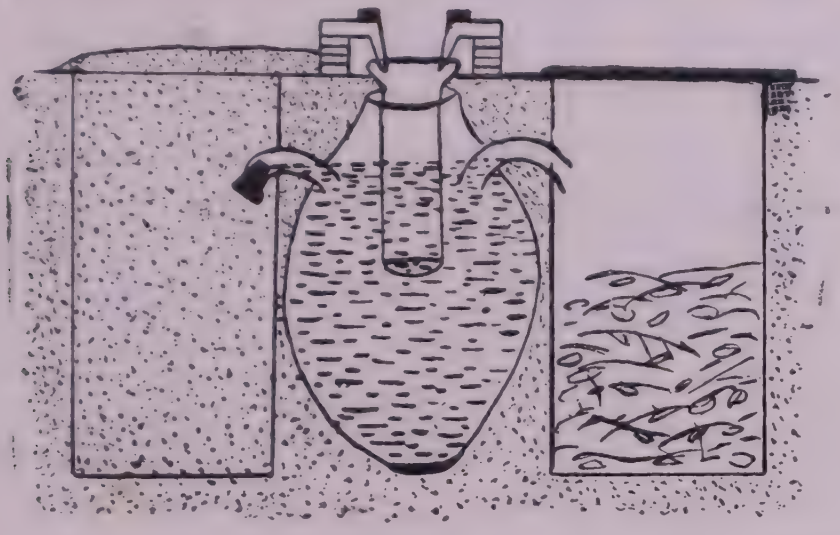


Fig. 16

cover for the pit in use. Curved 3 inch pipes are needed for the outlets. A 4 inch glazed pipe is best for the inlet. A squat plate of any material can be made over the inlet pipe. The latrine requires little water to flush and gives no odor.

10. Cement Water Seal Latrine (Fig. 17)

Several cement water-seal latrines have been constructed in the villages. They are generally installed in

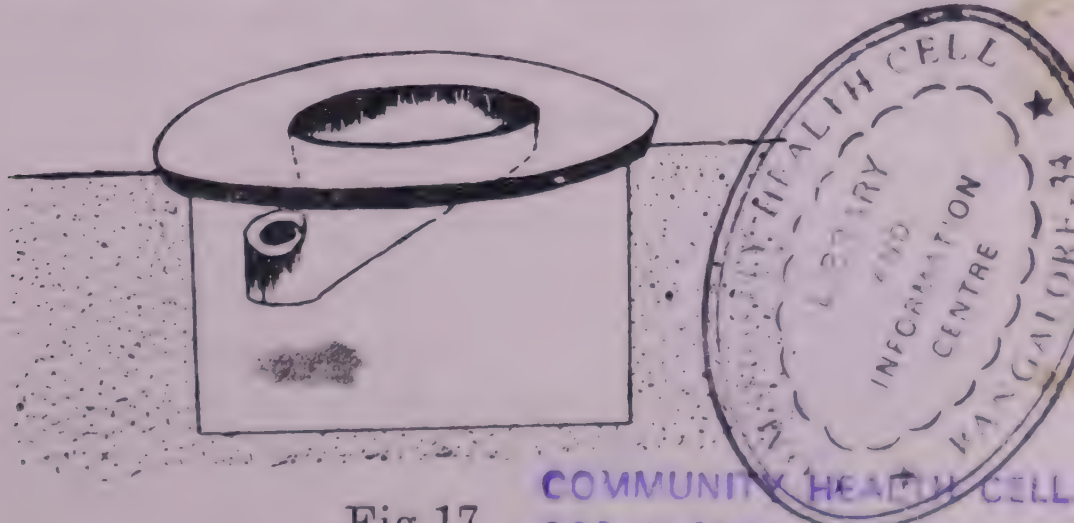


Fig 17

COMMUNITY HEALTH CELL
336, V Main, I Block
Kasturi Nagar
Bangalore-560 043
TM-110

a cement slab and placed over a pit from which compost can be made. The seal can be made in a wood mold* or more simply by plastering cement by hand around a wood or cement form. The form can be removed in two pieces. In one method the form is split lengthwise with the seal, the form removed and the seal cemented together again. In another method half of the U part of the form is removed from one end and the rest from the other end. Oiled paper about the form aids in obtaining a smooth inner surface. These latrines are very durable but require more water to flush than the aqua privy or rubber air seal.

* Village Service, Barpali,
Barpali Dr. Sambalpur, Orissa.

CHAPTER VIII

MALARIA

Malaria is a group of closely related infections caused by several different one-celled parasites that live chiefly in the blood. The disease is transmitted from man to man by the bite of female anopheline mosquitoes. The disease is characterized by chills and fever which occur periodically daily, every other day or every third day. Each type of fever is caused by a different kind of parasite. It is possible to have more than one type at a time. Chronic cases have anemia and a large spleen. Some tolerance may be had for the parasite but no real immunity develops. Relapses are common. There are many carriers where the disease is prevalent.

There are at least three separate malarial parasites of man, namely: (1) *Plasmodium malaria*, quartan fever; (2) *Plasmodium vivax*, tertian fever; and (3) *Plasmodium falcicarum* or tropical malaria.

Malaria is the most prevalent of all preventible diseases, save malnutrition. In spite of the fact that the disease has been thoroughly studied and the diagnosis, treatment, transmission and prevention are well known, malaria has a higher morbidity rate and is responsible for more deaths than any other transmissible disease. It is widely distributed but is most prevalent and virulent in warm moist climates. Wherever malaria prevails, and almost in direct proportion to its prevalence, the population is weak and poor.

Malaria is peculiar to man; there is no animal reservoir in nature. Anopheline mosquitoes only are capable of transmitting the malarial parasites to man. More than 120 species of anophelines have been identified, but only about twenty of these transmit malaria.

Anopheles are brownish and rather large. They sit almost at right angles upon the skin. They are active at night and breed chiefly in open ponds, puddles, and natural collections of water in the woods, fields and swamps. Each species has its own particular habits and habitat. Soak pits for waste water are common breeding places.

The mosquito becomes infected upon drinking the blood of a person carrying malaria parasites in the blood. It takes about 2 to 5 weeks for the parasite to develop and multiply in the mosquito. The mosquito cannot transmit the infection to another person for this period of time. In this interval the malarial parasites at first multiply to hundreds and thousands in the stomach of the mosquito. They then migrate to the salivary glands of the mosquito where they remain until injected into man. The mosquito is apparently not harmed by the presence of the malarial parasite.

When the mosquito feeds on a human subject these new parasites are released in the blood stream. They quickly disappear from the blood stream and enter the liver where they undergo a period of multiplication and development. After about one week the malarial parasites re-enter the blood stream and invade the red blood cells. In about another week the number of red blood cells affected and destroyed is high enough to produce fever. The parasites remain in the blood for 3 or 4 months although generally in decreasing numbers so that symptoms are not

present for this whole period. Some parasites may remain in the liver for years and give rise to a relapse at any time when the patient's resistence is lowered.

A typical attack of malaria has an abrupt onset frequently starting with a rigor. The temperature reaches 104° to 106°. Nausea and vomiting are common. After 20 to 60 minutes the hot stage begins, accompanied at first by relief from the sense of intense cold, but shortly followed by severe headache and a sensation of intense heat. The patient may become delirious for a short time. Vomiting may again occur. This is followed by the sweating stage. With this the temperature rapidly falls and the patient generally sleeps. He awakens somewhat exhausted but otherwise feeling well.

A person who once has had malaria seems more prone to have more attacks, which, in fact, may be relapses. However, repeated infections leave a pronounced resistance. There is no true racial immunity to this disease. The freedom from malaria which some persons enjoy may be accounted for partly by the fact that mosquitoes seldom bite such persons. Exposure, overeating, fasting, overwork, worry, or anything that lowers the vitality predisposes to an attack of malaria.

About 20% of apparently healthy people in malarial areas carry the parasites. Unrecognized malarial infection and incomplete treatment lead to the carrier state.

Malaria Control

The successful suppression of malaria requires a combined attack upon the mosquito and the parasite in man. Ultimate success rests upon the suppression of the mosquito. This does not mean elimination of the mosquito

which is practically impossible. It is a question of relative density of human population and anopheline population. The higher the density of human population the lower must be the mosquito population to prevent an outbreak of malaria.

Although anopheline mosquitoes may fly a mile, generally malaria is a local infection probably restricted to each village. It is quite possible to have a village free of malaria surrounded by villages with heavy infection.

The early stages in the development of the mosquito are aquatic, while the adult is winged. Mosquitoes never breed in damp grass, weeds or bushes, but the winged insects frequently rest and hide in vegetation. In the dry season they may hide in sheltered dark places.

Male mosquitoes are vegetarians. The female of many species have developed a taste for blood and in some species blood is necessary for the development of the mosquitoes' eggs. The mosquito usually lays her eggs upon the surface of the water. Those of anopheline float separately on their sides. In a day or two the eggs hatch out into larvae. Although the larva is an aquati animal, it is a true airbreather.

The larvae of anopheline mosquitoes rest and feed at the surface of water. The larva lies in an almost horizontal position, its tail touching the surface, where it breathes through a tube. The mosquito remains in the larval stage for about one week when it is transformed into the pupa. The pupa has no mouth and does not feed. It breathes through tubes on the surface. The pupal stage lasts 2 or 3 days when the adult winged insect emerges. The time between the laying of the egg and the emergence of the aduet insect may be as short as nine days.

Mosquito control naturally falls into two parts : (a) control of the aquatic stages and (b) control of the winged insect. The most effective measures are those which destroy the breeding places of mosquitoes and thus prevent their multiplication. For the best results, both individual and the communal efforts are necessary, but the importance of individual effort alone cannot be too much emphasized. Just clearing out breeding places on one's own premises is of benefit to each family because of the local habits of the mosquito.

Collections of water which may serve as breeding places may be dealt with by filling in or by drainage. For filling inorganic refuse such as ashes and scrapped building material may be used. Earth may be removed from a nearby hill or drain under construction. One of the best means of clearing the land of small collections of water is to place it under cultivation. One papaya tree will absorb the waste water from a home or well more efficiently than a soak pit.

When filling is not practicable, good and permanent results may be obtained by drainage. Collections of water containing fish or that can be stocked with fish need not be drained. Ditches must be of sufficient depth to completely drain the collection of water. Also the ditch must have sufficient fall to prevent stagnation along the course of the drain itself. Ditches should have clean sides and must be inspected frequently. If *kutcha*, the sides should slope gently so grass will cover the drain and prevent erosion.

There are many man-made breeding places. No body of water is too small for a mosquito nursery. Filling taken from the road-side to improve a road creates a hole and

a public nuisance. Discarded cans and buckets are favorite breeding places. Cisterns should be either covered or stocked with fish. The possible places are too numerous to list.

The above methods are the only practical and permanent ones. Until they can be made effective, less efficient and more expensive methods must be used.

Many larvicides are in use which give temporary suppression. Oil forms a thin film on the water surface which poisons and suffocates the larvae and pupae. Usually two parts of crude oil are thinned with one part of kerosene. Sufficient oil should be used to cover the entire surface with a thin film. As the oil is volatile, it disappears within a few days. Also wind may blow the oil to one side. Oiling must thus be repeated every 2 weeks. Oiling should be considered a temporary expedient which in the long run is rather expensive.

Paris green causes destruction of anopheline larvae. It may be prepared by mixing with ashes in the proportion of one part to a hundred. This mixture is thrown into the air on the windward side of the pond. Surface tension holds the fine particles on the surface. The larvae eat them and thus are destroyed.

DDT (dichloro-diphenyl-trichloroethane) is effective against both the larvae and the winged insect. DDT may be sprayed on walls where it has a marked residual effect on adult mosquitoes and many other insects which persists for a few weeks. Dosages which have been found to be effective against insects are not harmful to humans. However, dishes and food should be covered before spraying.

In areas where malaria is prevalent, personal prophylaxes should be used where economically feasible. Screening

of houses used at night and the use of a mosquito net at night will give some measure of protection.

Recently safe drugs have been found which while not preventing infection do suppress the symptoms of the disease. Among these Paludrine is most commonly used in this area. Taken once a week, 0.1 gm for children under 5 and 0.3 gm for those older, it is highly effective in preventing the symptoms, morbidity and mortality of malaria.

Finally malaria control requires effective treatment of each case of malaria to lower the human reservoir of malaria parasites.

CHAPTER IX

SMALLPOX AND VACCINATION

Smallpox is caused by a virus which is contained in the patient's skin lesions and in secretions from the mouth and nose. Viruses are even smaller than bacteria. They can be seen with a special type of microscope. The disease is characterized by an eruption all over the body developing about 12 days after exposure to a smallpox patient. The eruption comes out in a single crop of small raised lesions called papules, which at first are more numerous on the face and extremities. These soon form blisters or vesicles. The vesicles become filled with pus forming pustules. When the pustules break crusts are formed. As the crusts fall off a scar or pox mark is left on the skin. There is generally a high fever and the patient is very sick. About 25% of patients die of the disease.

It is important to distinguish smallpox from the milder disease chickenpox. The lesions of chickenpox come out in successive crops which always start on the trunk and never on the face or extremities. The lesions are seen in different stages of development, the oldest being on the trunk. The patient is generally not very sick. The mortality rate is very low.

Smallpox was once very prevalent killing lakhs of people yearly. Practically everyone got the disease as its occurence is completely independent of such conditions as

race, sex. climate, occupation or sanitary surroundings. There is no medicine known that will cure smallpox and there is only one practical way of preventing it, by vaccination. Through widespread vaccination the incidence of the disease has rapidly declined and it is almost unknown in certain western countries. Unfortunately it is still prevalent in our villages.

Vaccination consists of introducing the virus of cowpox into the skin with the purpose of giving the person cowpox in order to prevent smallpox. Vaccination gives immunity to both smallpox and cowpox in 8 days and lasts a number of years. It is generally recommended that vaccination be repeated every 7 years and on exposure to a case of smallpox. Vaccination is a safe procedure causing little fever or discomfort. The site of vaccination develops a typical lesion which goes through all the stages of a single pox. With the first vaccination the lesion developes over a two week period and heals in another two weeks. Subsequent vaccinations give milder reactions which develop and heal faster.

It is not necessary to put anything over the vaccination site. Covering with cow dung and mud is very dangerous. Simply keep it clean and dry. If no reaction occurs on the first vaccination it should be repeated.

In the unfortunate event that a person in the village should get smallpox the local health authority should be notified immediately. All contacts with the patient should be revaccinated and the patient isolated in a separate room. The person caring for the patient only should be permitted to enter the room and he must be someone who has been vaccinated. Isolation should be maintained until all crusts have fallen off. These crusts and any discharges from the

nose and mouth must be burned. Bedding should be boiled. The advice of a doctor should always be sought.

Smallpox can be completely eliminated from our villages if full cooperation is given to the vaccinator. Our people must be told the benefits of vaccination and that vaccination is a safe procedure. The infant should be vaccinated on the first visit of the vaccinator. To be vaccinated on the day of birth is not too early.

CHAPTER X

COMMON CONTAGIOUS DISEASES OF CHILDREN

The teacher should recognize the common contagious diseases of children so as to be able to advise parents in the community regarding treatment and isolation technique. School children are of necessity in close contact, so that prompt action must be taken if school epidemics are to be avoided.

Measles

Measles is a highly contagious disease caused by a virus. Viruses are living germs even smaller than bacteria. They are found in the secretions of the nose and throat of patients. The virus is spread through the air from the nose of one person to that of another as people talk, cough or sneeze.

For 10 or 12 days after exposure to measles, no symptoms occur. This is known as the incubation period. Following this fever, cough, nasal discharge and conjunctivitis develop. Frequently small white spots are seen inside the mouth near the lower molar teeth.

In a day or two after the appearance of these small white spots, the typical rash of measles breaks—out. The rash has a reddish hue and generally first appears on the forehead or behind the ears and gradually spreads downward. As the rash spreads, the symptoms become worse, the temperature generally rising to 105. But by the time the rash

reaches the legs in about three days, there is marked improvement. If this improvement fails to appear, it is a sign that the measles is probably complicated by another disease, such as pneumonia or an ear infection. With the improvement in symptoms, the rash begins to fade, starting with the face and reaching the extremities in another 2 days.

The patient is contagious from the time the symptoms appear, which is about 2 to 4 days before the appearance of the rash. He remains contagious until 5 days after the appearance of the rash. So the first step to be taken when measles is suspected is to isolate the patient. It is particularly important that the patient be kept away from children under 2 years of age, as the disease is more dangerous to them. On the other hand, people with cough and colds should not attend the patient as this may increase the chances of complication occuring. Whenever possible the patient should be isolated in a dark room, as light irritates the eyes. A nutritious diet of liquid and soft foods should be given, with plenty of water. Milk, fruit juice, *ambil* and *gur* syrup are most helpful. If the temperature does not drop soon after the rash reaches the legs, the child should be taken to a doctor, as a serious infection has probably developed. If the child improves, he may return to school one week after the appearance of the rash.

German Measles

German measles is similar to measles but is caused by a different virus and is a milder disease. People generally consider German measles as a second attack of measles. Actually a second attack of measles or German measles almost never occurs. The incubation period of German measles is 14 to 21 days. A day or two before the rash there is slight fever, headache and swollen, tender glands

behind the ears. The rash is similar to that of measles but spreads more rapidly and disappears by the third day. The symptoms are also similar to measles but generally less severe. Complications are not common. The treatment is the same as for measles.

There is only one serious condition due to German measles. If a mother develops German measles in the first three months of pregnancy, it is quite likely that the baby will be born with defects such as deafness, heart disease or cataracts. It is for this reason that we recommend that female children be purposely exposed to German measles so there will be no chance of getting it in later life. Any mother exposed to and contracting German measles in the first three months of pregnancy should consult a doctor as soon as possible.

Chickenpox

Chickenpox is another highly contagious virus disease. It is spread in a manner similar to that of measles and second attacks are very rare. The incubation period is about 2 weeks, after which there is generally one day of fever before the typical rash breaks out. The rash consists of small vesicles, i. e. fluid-filled lesions, developing over a peroid of three to four days, starting on the body and spreading later to the face and extremities. The lesions first appear as slightly raised solid, reddish elevations of the skin, then become filled with fluid and finally break forming a dry crust. The crust falls off in about a week after the rash appears and the patient can be considered non-infectious at that time. The lesions appear in crops, so that all stages of the lesions may be seen at once. This is in contrast to smallpox where all the lesions are in the same stage and appear on the face and extremities first.

Complications from chickenpox are not common. The patient should be isolated for one week. The child's nails should be cut short to avoid scratching the lesions and thus bringing a new infection. A daily bath should be given. A soft nutritious diet should be fed. If the fever persists longer than a week, a doctor must be consulted.

Mumps

Mumps is another contagious virus disese causing painful enlargement of the salivary glands, especially the parotid glands just at the ear lobes. The incubation period is between one and three weeks. The patient is infectious a few days before the swelling and remains so until the swelling subsides. The swelling generally lasts about 10 days. The patient should be isolated during this period and given a nutritious soft diet.

In boys past puberty the infection occasionally spreads to the testes. In such cases a doctor should be consulted.

Whooping cough

Whooping cough is a contagious disease caused by bacteria called *Hemophilus pertussis*. It is characterized by a series of coughs ending in a forced inspiration (the whoop) and frequently followed by vomiting. The incubation period is from one to two weeks. The disease last about six weeks. During the first two weeks a severe cough develops. During the second two weeks the whoop develops and the patient is most uncomfortable. In the last two weeks the whoop becomes less severe, vomiting disappears and the patient's appetite returns.

Whooping cough is frequently complicated by pneumonia and other serious diseases. It is best that all patients be taken to a doctor. It is particularly dangerous to children

under 2 years of age, so particular care must be taken to protect small children from exposure to the whooping cough patient.

The patient should be isolaled for 6 weeks. Small frequent feedings of liquids are advisable during the period of the whoop. A vaccine exists for protection against whooping cough. It must be given before the onset of the disease to be effective. The immunization can be combined with that for tetanus and diphtheria. It is hoped that in the not too distant future these immunizations will be available to all children.

Diphtheria

Diphtheria is an infectious disease caused by bacteria. The disease affects the throat where the bacteria grow on a grey membrane. The bacteria produce a powerful poison that is absorbed into the blood stream and spreads to all tissues of the body. If the child is taken to a doctor early enough, he may be given a medicine to neutralize this poison and possibly save the child's life.

The incubation period is about 4 days. The membrane on the throat develops in a few days and there is high fever and frequently difficulty in breathing. Any child suspected of having diphtheria should be taken to a doctor at once. The routine immunization of all children against tetanus, whooping cough and diphtheria could eliminate these diseases from our villages.

CHAPTER XI

TUBERCULOSIS

Tuberculosis is a major cause of death and sickness in India today. It is caused by a bacterium, the tubercle bacillus, and is spread by a patient coughing up sputum in the presence of others and from drinking unboiled milk of tuberculous cows. The type spread by the respiratory system usually affects the lungs. The cow type usually affects the intestines. But either can be spread by the blood stream to affect any part of the body. Tuberculosis is generally a chronic disease that slowly lowers a person's vitality and after a period of years may cause death. Fever, loss of weight and cough are common symptoms but are not necessarily present.

There is a difference between tuberculosis infection and the disease tuberculosis. Over half of the people in many of our villages have had tuberculosis infection, but few develop symptoms of the disease. In the vast majority the body reacts to the infection by localizing it in a small area and preventing it from spreading to cause serious damage. Those who are not able to resist the infection develop symptoms of the disease. The power of resistance is determined by many factors such as age, nutrition and race. Children are more susceptible. Malnutrition and other diseases lower a person's resistance to tuberculosis.

Pigmented races seem more susceptible than non-pigmented. The dosage of tubercle bacilli is also important. Thus living under crowded conditions in a house with a tuberculosis patient increases the chance of disease. Therefore tuberculosis tends to be a disease of the poor.

Many patients with tuberculosis recover with rest, good food and fresh air. This is the treatment used for many years and is still important today. We have now in addition medicines that are quite effective in arresting the disease. But at best treatment extends over a period of months or years. The patient should always be under a doctor's care. Ideally all should be isolated in the hospital. Unfortunately there are not enough hospital beds available and most must be treated at home. In the home strict isolation must be observed. The patient must have a separate room, separate eating utensils, separate clothing and bedding. Discharges from his mouth, if he coughs, should be collected in paper and burned; children must have no contact with the patient and if at all possible should not be in the same house.

When a person is infected with tubercle bacilli, changes occur in all the tissues of his body which make the reaction of his tissues to a second infection more vigorous. Thus a second infection is more easily controlled than the first. For this reason a person is better off who has had the infection but not developed the disease than one who has had no infection at all. It is easy for a doctor to determine whether or not a person has been infected at some time in his life with tubercle bacilli. If a small amount of material made from dead tubercle bacilli is injected into the skin, a red swelling will develop in two days in those who have been infected.

For many years a vaccine has been sought that would give this increased tissue resistance but not cause tuberculosis, such as cowpox vaccine gives immunity to smallpox. A special preparation of tubercle bacilli so altered as not to cause symptoms of tuberculosis has been developed known as B. C. G. vaccine. When injected it produces a fair degree of immunity to tuberculosis which lasts for at least a few years. The vaccine is given to those who have not been naturally infected with tubercle bacilli. The wide spread use of this vaccine in our villages will surely reduce the number of cases of tuberculosis in the future.

The prevention of tuberculosis is closely related to the early diagnosis of active cases in the community. The doctor's examination and search for tubercle bacilli in specimens of sputa under the microscope is helpful. But there is really no good substitute for an x-ray of the chest for the early diagnosis of tuberculosis of the lung. Prevention of intestinal tuberculosis involves the boiling of milk for two minutes. The general raising of levels of nutrition and improving housing to avoid congestion and permit more light and fresh air in each room will do more than anything to prevent the heavy toll of life and vigorous health this disease takes each year.

CHAPTER XII

LEPROSY

Leprosy is an infectious disease caused by the bacteria, *Mycobacterium leprae*. The bacteria are similar to the tubercle bacilli as are certain aspects of the disease. It is a chronic disease. Treatment must extend over long periods of time. The reaction of the body tissues to the bacteria is important in determining the seriousness of the infection. Children are more susceptible than adults.

The most obvious damage is in the skin and nerves. Raised or flat areas may be seen and in these sensations is absent. Nodules may form on the face and hands. Nerve damage causes not only loss of sensation but many deformities, especially of the hands and feet.

Leprosy is common in India with about 1,500,000 cases. The disease is not highly contagious but prolonged contact as between members of a family will frequently spread the disease. Ideally all cases should be detected, isolated and treated. This is not possible in India today. It should be possible however to detect and treat a high percentage of leprosy patients from clinics. More clinics are being opened each year and attendance is most encouraging. Patients can see their lesions slowly disappearing with their own eyes. What was for centuries an incurable disease is now bowing to the newer wonder drugs.

Most leprosy patients are still not under treatment. Many hide their disease not knowing they can be helped. Not only can the disease be arrested, but many deformities can be improved. Our villagers with leprosy must be informed of these new opportunities.

PART II

NUTRITION

CHAPTER XIII

BODY BUILDING FOODS

Food is essential for life and good health. The lack of food is responsible for India's greatest health problem, malnutrition. It is not only the amount of food eaten that is important but also the kind of food and the method of preparation. Much can be done to improve diets with foods now available in the villages. Ancient India through years of experience had developed healthy dietary habits. Today much of the tradition has been lost or converted to meaningless ritual.

The material that the body is made of is not permanently ours even during our life. Our tissues are constantly being broken down and re-formed by food. We may look very much the same now as we looked a year ago, but actually most of the tissues of our body have been destroyed and reconstructed during this time. The body is indeed a remarkable machine, and food is its fuel as well as its material for repairs. Its repairs are done with the utmost precision when proper material is provided.

Foods may be divided into two groups: (1) body building foods, and (2) energy foods. In the first group are proteins, vitamins and minerals. In the second are carbohydrates and fats. However protein can also be used as energy food when carbohydrate and fat are not available.

The energy of protein, carbohydrate and fat is measured in calories. One calorie has the energy of the heat required to raise the temperature of a kilogram of water 1° centigrade. There are approximately 4 calories in one gram of carbohydrate or protein and 9 calories in a gram of fat. The minerals are measured in weight units such as grams or milligrams. Vitamins are measured in weight units or arbitrary units which have become standard throughout the world.

Protein is the most important of all foods. It is concerned with body building and body repair. It is thus most essential to growing children, the sick and in old age. Greater amounts are also required for pregnant and lactating women. Protein is found in foods of animal and vegetable origin. The main animal sources are milk and milk products, eggs, fish and meat. Vegetables high in proteins are pulses, grains and nuts. It is recommended that one gram of protein per kilogram of body weight be taken by adults.

All matter is made up of small particles called molecules. These molecules are extremely small and cannot be seen even with the ordinary microscope. Protein molecules in turn are made up of still smaller units called amino acids. Amino acids are composed of the elements carbon, hydrogen, oxygen, nitrogen and sulfur. So far 23 different amino acids have been found in humans. These amino acids are joined together in endless combinations making the structure of the protein molecule remarkably complicated. The protein of each organ of the body is different in the same individual. It is different again for each species of plant and animal. Of the 23 amino acids found in humans, 8 are known as essential

acids. These cannot be synthesized by our bodies but must be taken pre-formed in food. Proteins are thus graded as of high or low biologic value according to their content of these essential amino acids, or their ability to replace tissue protein. In general proteins of animal origin are more similar to those of our body and therefore of high biologic value, and should constitute at least 1/5 of our diet protein. Green leafy vegetables have high grade protein but small in amount. The protein of most grains is of high biologic value if the grain is ground whole or hand-pounded. It is the outer layer which is rich in protein, the center being mainly carbohydrate. Taking grain and pulse in the same meal will help supply all 8 essential amino acids. All eight must be taken together if they are to build our body tissues as our body cannot store amino acids longer than four hours.

Deficiency of proteins of high biologic value is one of the common faults of Indian diets. It leads to anemia, low resistance to disease, retarded growth of children.

Minerals make up about 1/25 of our body weight. Most of this is concentrated in bone which acts as a great storage place for minerals. Minerals are essential in the functioning of every cell of the body. The most essential alkali forming minerals are calcium, iron, copper, manganese, potassium and sodium. These are found abundantly in honey, jaggery (gur), green vegetables, roots, fruit, milk and milk products. Phosphorus, iodine, sulfur and chlorine are important acid forming elements. These minerals, like all other substances of the body are continuously being excreted and must therefore be replaced. Those most likely to be deficient in a poor diet are calcium and iron.

Calcium is required in larger amounts than the other minerals. It is one of the most common deficiencies in the Indian diet. About 99% of the calcium is deposited in the teeth and bones. Calcium is needed in greater amounts in growing children and pregnant and lactating women. The average adult requires 1 gram a day. The chief sources of calcium are milk and milk products, eggs, and green leafy vegetables such as amaranth, fenugreek, and drumstick leaves. Deficiency of calcium causes nervous irritability and fatigue. In children it causes stunted growth and deformed teeth. The small size of Indian children at birth is partially due to the low calcium diet of mothers. Calcium deficiency is probably an important factor in the small statute of many Indian children.

Iron is an important constituent of hemoglobin, the red pigment of blood which carries oxygen to all parts of the body. Only 30 mg. a day are required for adults. Many of the people in India, fail to get this much iron in their diet. The result of iron deficiency is anemia and weakness. At birth the infant has a 6 months supply of iron stored in his liver. There is only a negligible amount of iron in milk. If an infant is fed only breast milk after 6 months of age anemia is inevitable. People suffering from malaria, hookworm, tuberculosis and other diseases causing destruction of red blood cells require greater amounts of iron. The richest sources of iron are meat, egg, whole grain, pulses and leafy green vegetables.

Iodine is essential for the proper functioning of the thyroid gland which controls the level of bodily activity. Deficiency leads to mental and physical retardation, and occassionally enlargement of the thyroid gland. In most areas of the world iodine is found in the drinking water.

In some areas it is absent. Rich sources are found in many sea foods and salt made from sea water.

Sodium chloride or common salt is essential to the body. It is important in regulating the acidity of the blood. Less than a gram is generally required per day but the amount needed may be greatly increased in warm weather due to loss of salt in sweat.

The vitamins are organic compounds present in minute amounts in food and essential for health. They cannot be made by the body. Most must be taken pre-formed in food. They function in the body as catalysts. That is, in their presence certain functions in the cells of our body proceed at a very rapid rate. The vitamins are divided into two groups, the fat soluble vitamins A, D, E, and K and the water soluble vitamins B and C.

Vitamin A is present in some animal fats like butter and ghee, in whole milk, curds, egg yolk and meat. A very rich source is the liver of certain fish as the shark or cod. Vitamin A is not present in the vegetable kingdom where a precursor of it exists as carotene. This pigment was first found in carrots. Carotene acts like vitamin A in the body. It is found in leafy vegetables, drumstick leaves, amaranth, fenugreek, cabbage and ripe yellow fruit, as well as in carrots.

An adult requires about 3000 International Units of Vitamin A daily. Three to four ounces of leafy vegetables will generally furnish more than this. Vitamin A deficiency is the most common of all vitamin deficiencies in India. Children in particular are affected. Vitamin A deficiency results in skin diseases, particularly fungus diseases, night blindness and general poor development of children.

Vitamin D is essential for the formation of good bones. Deficiency of vitamin D causes rickets, a disease characterized mainly by deformities of bone. This is due to the fact that Vitamin D is necessary for calcium to be deposited in bone.

Vitamin D is also formed in the skin by the action of sunlight which transforms a precursor of vitamin D to vitamin D itself. Rickets actually should not exist in most parts of India with its abundant sunlight. Unfortunately, however, it is very common. Village houses are dark. Too many children are left indoors all day.

Vitamin D is found abundantly in animal oils and eggs. About 800 International Units are required for a child. One gram of vitamin D contains about 40,000,000 International Units (IU).

Vitamin K is concerned with the ability of the blood to clot. This vitamin is produced in sufficient quantities by the bacteria in our intestines.

The functions of vitamin E are not fully demonstrated in human. It is thought to be concerned with fertility. It is found in butter, fresh vegetable oils, the germ and seed of grains, bananas, plantains and leafy green vegetables.

Vitamin B complex contains several factors important in health, the most important of which are thiamine, riboflavin, nicotinic acid, pyridoxine, folic acid and vitamin B_{12}. Vitamin B_1, or thiamine, maintains normal functioning of nerves. It is required for utilization of carbohydrate. About 1 mg. of thiamine is required per day. Foods rich in thiamine are germ and outer coat of grains, pulses and groundnuts. Smaller amounts are contained in fresh vegetables and fruits. Milk is a poor source, but milk products formed by fermentation are rich in vitamin B_1.

Vitamin B_1 is destroyed by excessive heat as in milling cereals. There is no loss when the foods are dried.

Many feeding problems of infants and children are due to lack of vitamin B_1. Still greater deficiencies result in retarded growth, nervous irritability, and lowered resistance to infection. The most severe form of vitamin B_1 deficiency is beri-beri in which the nerves degenerate causing paralysis and altered sensation.

Vitamin B_2, or riboflavin, is necessary for growth of children and proper functioning of the central nervous and digestive systems. Daily requirements are 600 International Units. It is found in yeast, groundnuts, milk, egg yolk, germ and the outer coat of grains and pulses, leafy vegetables and yellow vegetables. It is not destroyed by ordinary heat or drying.

Deficiencies of vitamin B_2 lead to many eye diseases, sores at the angles of mouth and on the tongue. Skin diseases are also common. Nicotinic acid is essential for the health of the skin and of the nervous and digestive systems. It is one factor necessary for formation of blood. It is also essential for growth. Niacin is found in yeast, groundnuts, milk, leafy green vegetables and whole grains and grams. Deficiencies, cause anemia, skin diseases, and inflammation of the tongue. Severe deficiency causes pellagra characterized by mental disorders, diarrhea, marked loss of weight and even death. Niacin is synthesized by bacteria in the intestinal tract.

Pyridoxine, or vitamin B_6, is a sedative to the nervous system. It is found in egg yolk, butter, milk, vegetable oils, pulses and whole grains. Deficiency causes nervous irritability.

Folic acid is one factor necessary for production of red blood cells. It is found in curds and leafy green vegetables. It is easily destroyed by heat.

Vitamin B_{12} is another factor for maturation of red blood cells. It is not destroyed by ordinary cooking. Only a few micrograms are required per day. It is found abundantly in germ and outer coat of grains, egg yolk, yeast and milk. It is found in lesser amounts in leafy green vegetables and fruits.

Vitamin C is essential mainly for production of connective tissue. Connective tissue is widely distributed throughout all tissues of the body. It is found in the matrix of bone upon which calcium salts are deposited. It is the main tissue concerned with healing of wounds Daily requirements are about 50 mg. The richest source is *amla*, where it is also remarkably stable against heat and drying. *Amla* is widely distributed in the forests and gardens of India and thus obtainable at low cost. It may be used fresh during the season and dried for use throughout the year. Guava and most fruits and leafy green vegetables are also good sources of vitamin C. An all-year-round source is sprouted grains and pulses. Vitamin C is more stable in acid media. However, in most of these sources much of the vitamin C is destroyed by cooking.

Severe deficiencies of vitamin C lead to scurvy. In this disease there is poor bone formation in children. Connective tissue of blood vessels becomes defective and there may be bleeding from many parts of the body, as gums and intestines. Wounds fail to heal normally. Resistance to infection is lowered and many skin diseases appear.

CHAPTER XIV

ENERGY FOODS

The carbohydrates are the main energy foods supplying about 2/3 of the total energy for the body. This fuel is used in many ways by our bodies. The normal body temperature, the functions of respiration, circulation, digestion, excretion, etc. are illustrations. Energy is also expended in maintaining the structure of the body which is a dynamic rather than a static process. The energy that the body uses at complet rest is known as the Basal Metabolism. Additional energy is spent for the other activities such as work and play. About 2400 calories are needed per day for the average person, but this varies with age, sex, weight and occupation. The energy of food represents the power to do work. But it makes a great difference whether this is physical or mental work. An hour of moderate exercise may raise the body requirement from 100 calories per hour to 300. But the extra energy expended in an hour of mental work would amount to no more calories than can be supplied by half a groundnut.

The carbohydrates include the sugars, starch, and cellulose. There is a difference in the rate at which they are absorbed and made available for energy. Only the simplest sugars such as are found in honey and fruit can be absorbed directly into the blood stream from the intestines. The others must first be broken down tc simpler forms.

The simple sugars found in food are glucose and levulose. Glucose is the sugar that circulates in the blood. All other carbohydrates are converted to glucose in the body before being used for energy. Glucose is found in plantains and bananas that are tree ripened. Levulose is found in fruit and honey. It is the sweetest of all sugars.

The double sugars are lactose, maltose and sucrose. They are about doudle the size of simple sugars to which they must be broken down before being absorbed into the blood. Lactose is milk sugar. Maltose is formed from sprouting grains and pulses. Sucrose is found in palm and cane. Ordinary white table sugar is pure sucrose.

Complex sugars are the starches and cellulose. The splitting of starches begins with the action of saliva in the mouth and is completed in the intestines where starch is converted to simple sugars. Cellulose is the woody fibrous substance of plants and is not well digested. It serves as bulk in the intestine and helps regulate the bowels.

Fats are high energy foods. Exact amounts necessary in the diet are not known. Fat molecules are composed of small units called fatty acids. Just as we have certain essential amino acids of protein which cannot be synthesized in the body, so we have a few essential fatty acids found in fat which are essential for health and cannot be synthesized by the body. Three of these fatty acids are linoleic acid, linolenic acid and arachidonic acid. When these essential fatty acids are absent in the diet the body cannot store fat. Like proteins, the fats of animal origin are more similar to our own and are more

likely to contain these essential fatty acids. The best sources of fat are meat, butter, milk and ghee. Vegetable oils and fresh oil cake are also good sources. Most Indian diets are low in fats especially of animal origin. Some fat soluble vitamins are contained in fats. Fats are also necessary for absorption of these vitamins from the intestines.

Excessive intake of food is generally not seen in village India. Protein and vitamins taken in excess in food are merely used for energy. Excess in minerals is excreted in the urine. Excess intake of energy foods is deposited as fat in our body. By excess is meant more calories in food are taken than are used by our body. On the other hand if we expend more calories than we consume in our food, the difference will be withdrawn from our fat storage. When this supply is exhausted our body will use its own protein as fuel. Wasting of muscles is therefore expected in starvation. At this point our body will try to adjust its activities to a very low level. Thus the adult will walk and work very slowly. The child loses interest in play. Diseases due to lack of various body building foods generally appear as lack of these foods accompanies the shortages of energy foods. This is the picture of starvation which is seen so frequently in our villages that we do not even recognize it as abnormal.

CHAPTER XV

CALCULATION OF DIETS

Rather than wait for evidence of nutritional deficiencies to appear, it is far better to prevent such deficiencies by taking an adequate diet. To determine whether or not a diet is adequate it is necessary to calculate its content of calories, protein, carbohydrates, fat and the more important minerals and vitamins. A table of values of common Indian foods is given in the appendix. Figures are for one ounce of uncooked food. It is best to make a chart. A typical village diet from a jawar-growing area is illustrated in Table II.

The number of calories required varies with age and activity. The average adult doing light work requires about 2400 calories a day. The final test is whether or not the person is maintaining a good weight. Calories may be adjusted by the amount of carbohydrate and fat in the diet. In this village diet calories are low. Protein is adequate in amount assuming one gram per kilogram of body weight is required and the average adult to weigh about 55 kilograms. But the fraction from animal origin is very low, making increased amounts required. Fat and carbohydrate are only necessary to give adequate calories. Calcium is very deficient as is vitamin A and its precursor carotene. Iron is adequate but vitamin C is absent. The requirements of the vitamins and minerals are approximately the same for adults and children. The daily requirements are listed in the appendix.

The main deficiencies could be made up by adding one ounce of drumstick tree leaves to the *dal* and adding one ounce til cake to chutney. This would not raise appreciably the cost of the diet. Sprouting the *dal* would add about 25 mg. of vitamin C, or one *amla*, fresh or dried would give over 50 mg. vitamin C. Switching from whole to skimmed milk would permit increased quantities of milk at low cost and thus help raise the proportion from animal origin. This will lower the vitamin A in the diet which can be increased more economically by addition of inexpensive sources of carotene, as from carrots, dried or in season. Changing from milled to home pounded rice adds little to this diet, although it might be quite important in a rice growing area. Substituting *ragi* for part of the rice or *jaur* would help the calcium content of the diet and reduce its cost.

A review of the Food Values in the appendix will bring to mind many more opportunities to improve the village diet. Table III gives one example of an Improved Diet with little increase in expense. The problem is one of education rather than of poverty.

CHAPTER XVI

INFANT FEEDING

The most severe cases of malnutrition are seen among our infants and children. The quantity of food required to balance these diets is small and need not be expensive. Our village mothers simply have no idea of the child's requirements. Advice to mothers should be simple and accompanied where-ever possible by practical demonstrations where the mother may prepare the food herself.

Generally Indian babies are breast fed. Breast milk is the ideal food for the new born. It is not, however, a complete food. It is deficient in iron and vitamins C ann D. The baby's own store of iron is sufficient for 6 months, by which time solid food should have been started. Vitamin C should be given in the form of the juice of a fruit in season. It may be started after the first week of life. Only 2 to 3 teaspoonfuls are required daily, but the infant should be allowed to take as much as he likes. Vitamin D may be had by exposing the infant to the sun for an hour or two a day from about 2 weeks of age. In those parts of India where the sun does not shine for days at a time vitamin D must be given orally. A teaspoonful of shark liver oil twice a day will do.

Certain general principles must be observed in feeding an infant any supplement to breast milk. First is the matter of cleanliness. The infant is susceptible to all the diarrheal diseases. Therefore the mother must first wash her hands. Then the fruit should be washed. Finally the utensils used to cut the fruit and feed the baby should be boiled. Even new born infants will generally take orange juice from a spoon in the sitting position. The custom of pouring liquids into an infant's mouth while it is lying on its back is dangerous. The fluid may go directly into its lungs and cause serious illness. Second is the matter of timing. The infant will always prefer milk from its mother's breast to any other food. The trick is to permit the infant to get hungry and offer the fruit juice or other food first and afterwards the breast.

After each feeding the small infant should be sat erect to permit release of swallowed air. He may then be placed on his stomach or right side for a nap.

So our new-born is now on breast milk and fruit juice. How do we know the baby is getting all it needs? The baby will let you know. To be sure his vocabulary is limited to a cry, but there are so few common reasons for a baby to cry that it is easy to determine whether or not he is hungry. Generally the infant cries when he is tired, wet or hungry. If he is dry and has recently napped then the crying infant is generally hungry. Offer the baby the breast only when it is hungry. During the first month of life the infant will generally become hungry about every 4 hours, or 6 times a day. During the second month this period will generally be extended to every 6 hours or 4 times a day. If these habits have not been established by the third month you may be quite certain

the baby is not getting enough food. He may appear quite well to you, but if his diet is supplemented at this time he will grow faster and cry less. Fresh boiled milk diluted in half with boiled water is a good supplement to start with. But there is no harm in starting cereal at this age. But remember the two principles, cleanliness and timing.

It is best to give the extra food in the late evening. In this way the baby is apt to sleep through the night which will be most convenient for the mother. There should be no difficulty feeding a 3 month old infant liquids from a cup in the sitting position. The two principles, cleanliness and timing, must be adhered to and care taken not to frighten the baby. Only small sips should be given at a time. Never use force on any child at any time. Success may not come on the first day, but patience will surely be rewarded. The baby will let you know when he has had enough. He simply refuses to take more. There is no danger of over feeding an infant.

If cereal is chosen for the extra feeding it should be well cooked. Whole grain *jaur*, rice or wheat flour mixed into boiling water should cook at least ½ hour over a low fire. It should not be permitted to burn. In the last few minutes a pinch of *gur* may be added for flavor. The final product should be paste like. It may be fed from spoon or fingers. But remember the two principles, cleanliness and timing.

In any event it is well to start whole grain cereal before 6 months of age. Even if the baby is fat and satisfied with only 3 breast feedings a day, cereal should be started. It is the baby's source of iron. Starting solids at this time will also make weaning easier later. By 6

months the baby may take milk without dilution. It is also no longer necessary to boil its spoon and cup, but they must be carefully washed.

The infant may be given boiled and cooled water at any time it cries from thirst. After one year of age it is safe to use chlorinated water.

Between six months and one year of age the baby should be slowly introduced to fresh vegetables and fruits. These should be washed and well cooked without spices. When these are difficult to obtain, sprouted *dal* will serve as well. Meat and half boiled eggs may now be added if not against religious practice. If meat or eggs cannot be given, it becomes more important to give milk daily. Whole milk is preferred, but skimmed milk or butter-milk is much better than none at all.

In this way the baby will gradually wean itself on to a well balanced diet by one year of age. If not weaned about this time it becomes a problem later, particularly if the baby has not been started on solid food. The worst cases of malnutrtion in India are 2 and 3 year old children who have not been weaned. The mother will also be spared the strain of prolonged nursing. Most failures in weaning are failures to follow the two principles, cleanliness and timing. A tight binder across the breast will also discourage the production of milk. Generally our village mothers make no attempt at weaning. As the production of milk decreases the breast becomes more of a pacifier than a source of food. The child becomes slowly conditioned to frequent inadequate feedings, loses interest in play, fails to gain weight, becomes anemic, and develops symptoms of multiple vitamin deficiencies. This is the price the child pays for our failure to educate village mothers.

CHAPTER XVII

PREPARATION OF FOODS

The preparation of foods may either enhance or lower their nutritive value. Heating, besides making food more palatable, also makes it more easily digested. In vegetables, starch and cellulose cells are broken. The fibrous tissue of meat is also broken. The heat causes little loss of proteins, carbohydrates and fats. Minerals are not affected at all. The various vitamins are little affected by ordinary cooking except vitamin C which is in large measure destroyed. As a general rule one should cook each item as little as needed to make the food palatable, digestible and sterile. Tender green leafy vegetables should be put in the *bhaji* for the last few minutes of cooking only.

A more serious loss comes from leaching of valuable nutrients into the water foods are washed with or boiled in. The washing of rice causes the loss of thiamine, nicotinic acid, phosphorus and other minerals. The loss of these from parboiled rice is not very great, as these nutrients have diffused into the starch core of each grain by the parboiling. Any residual water after boiling foods is certain to contain valuable minerals and water soluble vitamins. This water should be used in some form in the meal. Steaming of foods avoids this difficulty. The skin of root vegetables gives some protection against leaching loss. This protection is lost of course if the skin is removed.

Addition of alkali as sodium bicarbonate increases the loss of vitamins during cooking. On the other hand, acid foods like tamarind help preserve vitamins. Vitamin C is lost much more easily than other vitamins. Whether by washing, cooking or just exposure to the air. It is therefore desirable to include some raw fruit or vegetables in the diet. One *amla*, however, even after drying, will generally contain the day's requirements of vitamin C.

The valuable vitamins, minerals and protein of rice are contained in its outer layers. Some of this is lost in milling whereas it is preserved in hand-pounded rice.

Pulses and grains are devoid of vitamin C in the dry state. If permitted to sprout they gain about 5 milligrams per ounce. One method of sprouting is to soak the grain for 24 hours in water after which it is spread out between two pieces of damp cloth. In one to three days, varying with air temperature and variety of grain, the sprout will be about $\frac{1}{2}$ inch long. Most of the vitamins are in the grain part. The sprouted grain must not be cooked but should be eaten raw. It may be mixed uncooked with *bhaji* or chutney.

The green tops of root vegetables are generally rich in the protective foods. They should never be discarded. The various oil cakes are rich in calcium and can nicely be included in chutney.

Spices add little to the meal except flavor. An excess can be irritating to the digestive system.

The addition of an ounce of drumstick tree leaves in the last few minutes of preparation of *bhaji* will give the day's requirements of calcium and vitamins A and C. Buttermilk or other preparations made by molds or bacteria will insure a supply of vitamin B_{12}.

Due to poor transportation and lack of modern storage facilities, the season for various fruits and vegetables is likely to be short. But in season, these foods may be abundant at low prices. Preserving foods in season to be used later will add variety to the diet besides providing valuable body building foods throughout the year.

All methods of food preservation are based on inhibiting the growth of bacteria in food, which is the cause of food spoiling.

The simplest method of food preservation is sun drying. Bacteria cannot grow without water. An endless number of fruits and vegetables can be preserved in this manner for long periods of time in an air-tight tin.

Salting is another easy method. Bacteria are unable to grow in high concentrations of salt (2 to 3%). The vegetables are immersed under water containing one ounce of common salt per seer of water. The vegetables must remain under the liquid. They may be weighted with a piece of stone or wood. They should keep in this way for several months. Pickling of fruits and vegetables is essentially the same process except that spices have been added to the fluid. Chutneys generally are cooked with high concentrations of both sugars and salt and made acid with vinegar or lemon juice.

High concentrations of sugar also inhibit the growth of bacteria. This is the basis of preserving fruit in jams, jellies, or candy. For jams the fruit is peeled, seeded and cut into pieces. Then it is cooked until soft and an equal quantity of sugar by weight added for sour fruits or three fourths of sugar by weight for sweeter varieties. The mixture is cooked until it approximates the desired consistency. The jam is poured into a glass or ceramic

container while hot and sealed by layering melted candle wax over the exposed surface. Jellies such as guava jelly are a bit more complicated. The fruit is cut into small pieces and boiled for half an hour. It is then strained through a piece of coarse cloth. Additional juice is extracted twice again by adding about one-fourth the weight in water. This is allowed to settle over night and the clear liquid which is rich in pectin is poured off. It is the pectin that forms the jelly. To each cup of this clear extract is added ½ cup of sugar. This is brought to a boil and bottled with a wax seal. Thin slices of orange peel make a nice candy when cooked with sugar and allowed to dry.

Finally bacteria may be destroyed by heat in special air-tight bottles or cans.

The methods are described in a brochure *Preparation and Preservation of Fruit Juice* published by the Institute of Food Technology, Mysore.

PART III

PHYSIOLOGY AND FIRST AID

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CHAPTER XVIII

BODY TISSUES

Poor communications in village India leave many areas isolated from good medical care. It is therefore important that knowledge of First Aid be spread through our villages. Serious diseases should be recognized early. Injuries should be handled so as to make the doctor's job less difficult and give the patient the best chance of recovery.

Memorizing a set of procedures will be of little help when an emergency arises. Only with an understanding of the forms and functions of the body shall we be able to act promptly and with confidence. Such information, in any event, should be part of our general knowledge.

Physiology is the study of normal bodily functions. The smallest structural unit is the cell. It is too small

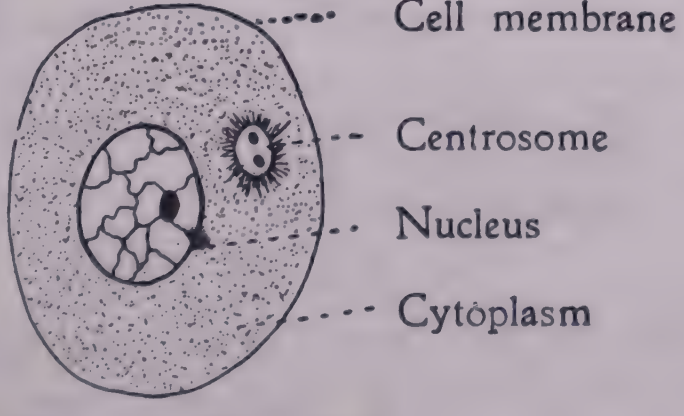


Fig. 18 The Cell

to be seen with the naked eye, but may be seen through a microscope. The cell is composed of protoplasm in which the many chemical reactions sustaining life occur. The protoplasm of the cell is divided into several parts. Surrounding the cell is a thin cell membrane. Near the center is the dense nucleus. Near the nucleus lies the centrosome. The remaining protoplasm is known as cytoplasm.

Growth and repair of our body occurs through cell division or mitosis. In this process the centrosome divides and chromosomes are formed in the nucleus. Forty eight

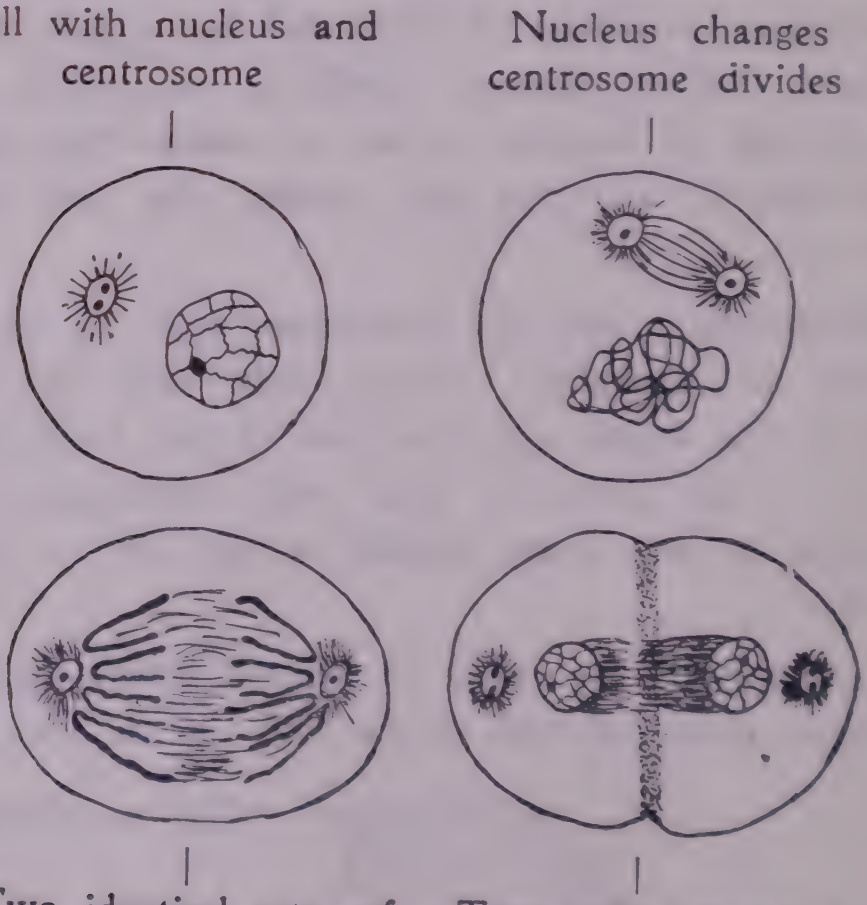

Cell with nucleus and centrosome
Nucleus changes centrosome divides
Two identical sets of chromosomes being attracted to the Poles
Two cells separating

Fig. 19. Mitosis

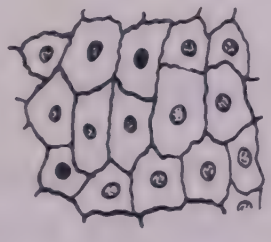
chromosomes are formed in all cells except the sex cells, sperm and ovum. In these only twenty four are formed. Each chromosome splits longitudinally, half going to each

centrosome to form two new nuclei. The cell membrane then constricts between the nuclei and two new cells are formed.

The cells are grouped together to form the tissues. There are four tissues, epithelial, muscular, nervous and connective. Each is designed for a different function in the body.

Epithelial tissue is lining tissue. Examples are skin, the lining of the mouth and intestines and the interior of the organs of the body and body cavities. The cells

Pavement cells of Squamous Epithelium



Columnar Epithelial cells from Intestines

Fig 20. Epithelial Cells

have various shapes. Those lining the abdominal cavity are broad and flat making a smooth surface. Those lining the intestines are narrow and tall and capable of secreting digestive juices. The various organs of the body are formed mainly of epithelial tissue. Its functions are thus protective and secretory.

Muscular tissue has the power to contract. The cells form fibers which are able to shorten. Bunches of these fibers form individual muscles, which make the various movements of the body. There are three types of muscle tissue, voluntary, involuntary and heart muscle. The muscle fibers of voluntary muscles are cylindrical and striated. Over these muscles we have voluntary control. The cells of involuntary muscles are spindle shaped and non-striated. This type of muscle is not

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under voluntary control. Examples are the muscles which move our intestines or control the diameter of our blood

Voluntary striated skeletal muscle fiber

Involuntary smooth muscle fiber

Cardiac muscle fiber

Fig 21

Types of Muscle Cells

vessels. Heart muscle is one type of involuntary muscle that is faintly striated. The fibers are round, short and branching. The action of all three types of muscle is controlled by nerves. Heart muscle has the special property of rythmical contraction even when its nerve supply is removed.

Nervous tissue is like a network of telephone lines. Each nerve cell is like an individual line with connections at each end. In this way the various parts of the body are connected making possible coordinated movements. Contact is also made with the outside world through specialized nerve cells for sight, hearing, taste, touch, heat and pain. The ordinary nerve cell (See Fig. 35) consists of a cell body and a long fiber called the axon. The axon may connect with another nerve cell through small fibers on the cell body called dendrites. Or it may connect with some end organ such as muscle or a special sensory structure for touch in the skin. The cell bodies are located within the skull or spine. The axon may

leave this protected area. It is then generally covered with a white sheath.

Messages are sent in only one direction. Thus two separate sets of nerves are required, one for bringing sensory messages in, or afferent fibers, and another for sending messages to the muscle for action, or efferent fibers.

Connective tissue is widely distributed throughout the body and serves mainly to bind together other structures of the body. There are other specialized functions. The

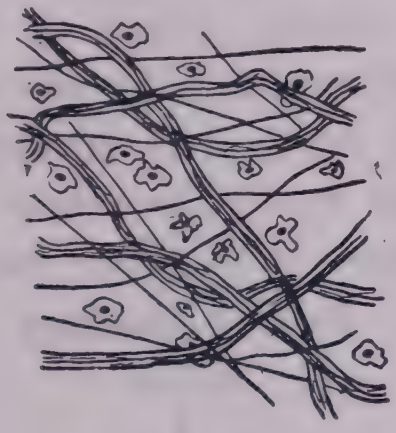


Fig. 22
Connective Tissue

ordinary connective tissue cell gives rise to a long fiber. The fibers become woven into a network that surrounds the various cells, organs, blood vessels, etc. Fat tissue is merely connective tissue fibers containing oil. Bone is essentially a specialized form of connective tissue upon which calcium has been deposited to give it rigidity. The ends of some bones are covered with cartilage, a smooth form of connective tissue.

Connective tissue is important in wound healing. Vitamin C is essential for its production.

CHAPTER XIX

THE DIGESTIVE SYSTEM

The function of the digestive system is to prepare our food for absorption into the blood stream. This means carbohydrate must be broken down to simple sugars, fat to fatty acids and protein to amino acids. The process was already started in the preparation of food by cutting into smaller pieces and softening in cooking.

In the mouth the food is cut and ground by the teeth. Children have twenty temporary teeth and adults thirty two permanent teeth. The incisors are used in

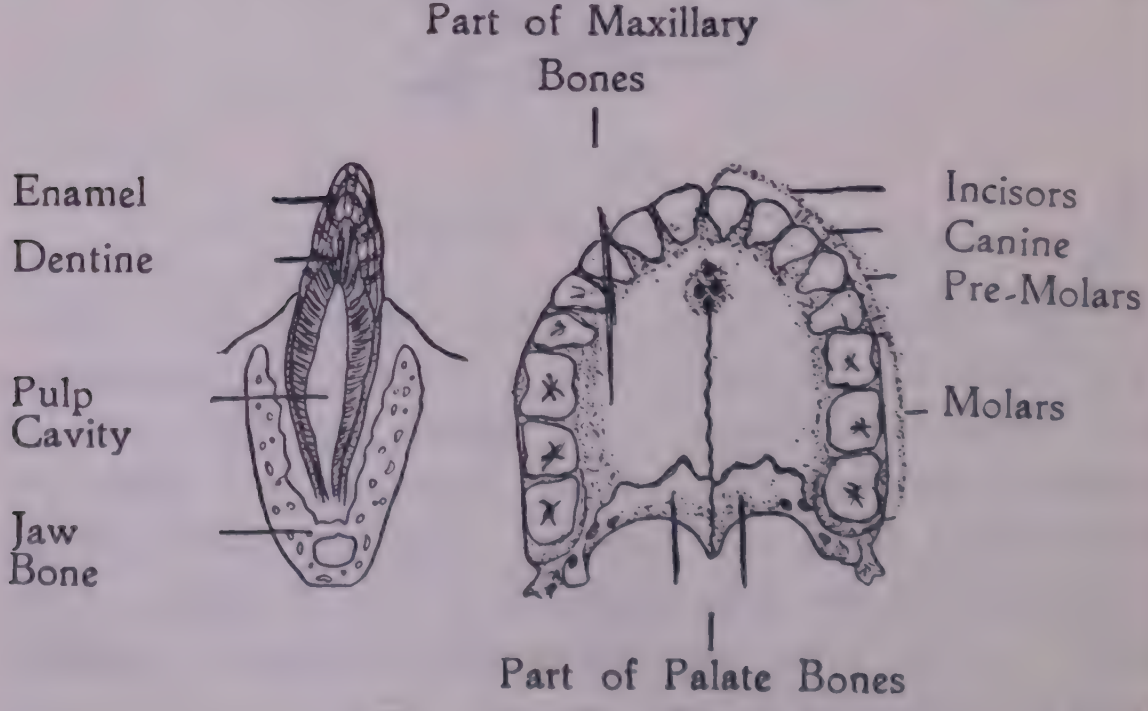


Fig. 23. The Teeth

cutting, the canines in tearing and the molars and premolars in grinding food. The crown of the tooth projects above

the gum and is covered with the body's hardest material, the enamel. Under this is another hard layer, the dentine which extends to the end of the root. Each root contains a root canal leading to the pulp cavity containing nerves and blood vessels which nourish the dentine and enamel.

If teeth are not properly brushed twice a day, food particles will remain in small depressions in the enamel. There acid forming bacteria will grow. The acid has the ability to dissolve the enamel producing a cavity which eventually destroys the tooth.

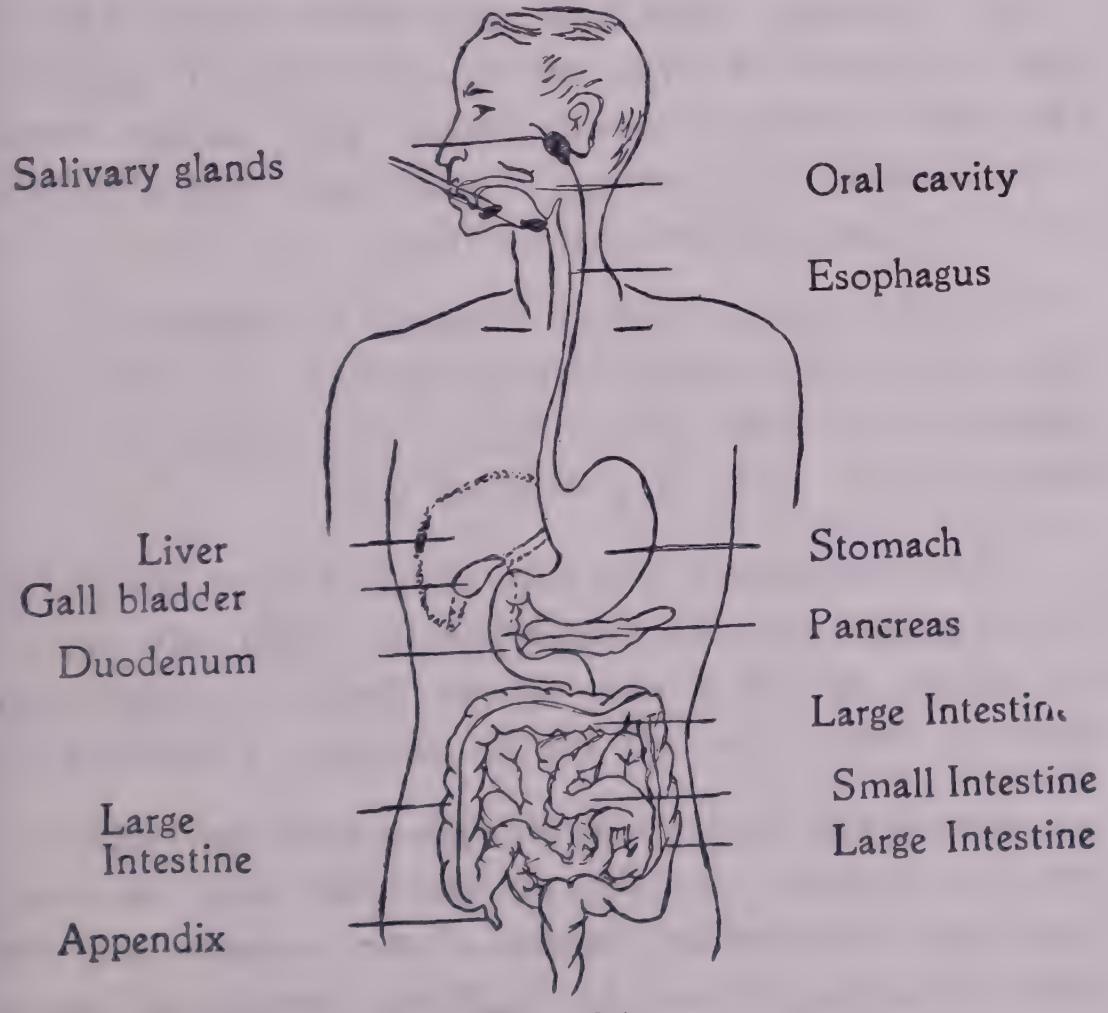


Fig. 24
The Digestive System

The mouth is bathed by saliva which is secreted by several glands. The largest of these glands is the parotid

gland located just below the ear lobe. It becomes swollen in mumps infection. Saliva is generally alkaline and gives some protection to our teeth against the destructive action of acid-forming bacteria.

The saliva also contains an enzyme. Enzymes are special proteins the presence of which speeds various chemical reactions in the body. The formation of enzymes by the body requires an adequate intake of the body-building foods. The enzymes secreted into the digestive system are concerned with fascilitating the breaking down of food to sugars, fatty acids and amino acids. This is done in a series of steps by several different enzymes. The one in saliva is called ptyalin and changes starch to the double sugar maltose. Ptyalin acts more effectively on well-cooked and well-chewed food.

As the food is chewed it comes in contact with the taste cells on the tongue. These help us to distinguish between good and spoiled food. Our sense of taste however is no guide to a balanced diet.

The well-chewed food is rolled into a lump and pushed by the tongue past the oropharynx in which are located the tonsils. As the tongue moves back it contacts the epiglottis, thus closing off the air passages. (See Fig. 48)

Swallowed food passes through a tube, the esophagus, into the stomach. In the stomach the food is made liquid by the churning motion of the stomach and the action of a juice formed by its lining known as gastric juice. The gastric juice is strongly acid and is generally able to kill most bacteria we swallow. Unfortunately some escape into the intestines to cause disease. The gastric juice contains at least two enzymes. Pepsin starts the

breakdown of protein to simpler combinations of amino acids called peptones. The other enzyme, rennin, curdles milk.

The liquid stomach contents pass a little at a time into the small intestine, the first part of which is called the duodenum. Into the duodenum are poured the secretions of the liver known as bile together with the secretions from the pancreas. Bile is stored in the gall bladder and released at mealtime. These secretions are alkaline. The pancreatic secretions contain three enzymes. Amylase breaks down carbohydrates to double sugars; it is more powerful than ptyalin. Lipase splits fats into fatty acids. Trypsin breaks down protein and peptones to very simple groupings of amino acids known as polypeptides. All these enzymes work best in the presence of bile.

The lining of the small intestine secretes an intestinal juice which completes the digestion of all foods. In this juice is found erepsin which converts peptones and polypeptides to amino acids. Three different enzymes split three different double sugars to simple sugars. Invertase acts on sucrose, lactase on lactose and maltase on maltose. Our food has then been converted to simple sugars, fatty acids and amino acids and is ready for absorption from the intestines.

The simple sugars and amino acids are carried by the blood stream to the liver. Some of the sugar is stored there and the rest converted into glucose and released in the general circulation to be distributed as nourishment to all cells of the body. The amino acids are in large part converted to human protein in the liver. The fatty acids are re-formed in the lining of the small intestines into very small globules of fat. These are absorbed into

the lymphatic system, a special system of vessels which empty into the blood circulation.

The small intestine attaches to the large intestine at the cecum located in the right lower part of the abdomen. The food takes about four hours to reach this point. The contents of the intestines are now mainly water, cellulose and bacteria, mostly dead. All nourishment has been absorbed. These contents have been moved along the intestines by rythmical contractions, called peristalsis. Attached to the cecum is a finger-like projection, the appendix. This sometimes becomes infected and if this happens it must be removed surgically at the earliest possible moment.

As the contents of the large intestine move toward its terminal portion, the rectum, water is absorbed and a semi-solid stool is formed. It takes about 24 hours to traverse the large intestine. The rectum is generally empty except just prior to defecation. This occurs at about the same time each day. It is brought about by a strong peristalsis starting at the stomach and traversing the small and large intestines. This is initiated in the morning after rising or after the first meal. The stool moves into the rectum and the urge to defecate is felt. The rectum is guarded by a round band of muscle at the anus.

The proper functioning of this mechanism depends upon regularity in emptying the rectum. This should be a matter of habit. The habit is commonly lost by disregarding the urge to defecate. When this occurs part of the stool moves backwards out of the rectum and into the lower large intestine. There it is further dehydrated and the stool becomes hard and we are then constipated. A hard stool is difficult to pass making for a tendency to delay defecation still longer. Thus a vicious circle is established.

The main treatment of constipation is to regain regular bowel habits. This is best done by increasing the intake of water and vegetables and fruits. The water helps keep the stool from becoming too dry. The vegetables and fruits increase the bulk of the stool due to their high cellulose content. A larger stool will give a stronger urge to defecate when it reaches the rectum. The constipated person should attempt to defecate at the same hour each day whether the urge is present or not. The best time is following the first meal.

It is best not to use cathartics at all. If they must be used they should be used for one or two doses only. The habitual use of cathartics makes the rectum insensitive and destroys the natural mechanism. The most certain way to produce constipation in an adult is to give that person cathartics regularly as a child.

There are three types of cathartics. The first group is the irritants. Castor oil is an example. They work by irritating the lining of the large intestine. The intestine in turn tries to get rid of the irritant by increasing its movements and secreting mucous to increase the bulk of the stool. This is the worst type of cathartic. The second group is the salts. They all contain magnesium sulfate which is not absorbed from the intestines. There is a tendency in the body for the concentration of all salts to become equal. In order to dilute the high concentration of magnesium sulfate in the intestines, water is drawn out of the blood stream into the intestines. This greatly increases the bulk of the stool and the urge to defecate is correspondingly stronger. The third group of cathartics is the bland oils. Paraffin oil is an example. This group merely softens the stool making it easier to pass. This is the safest group.

Cathartics should not be used when abdominal pain is present. If this pain is due to appendicitis, cathartics will greatly worsen the patient's condition.

It occasionally happens that a poison is swallowed. Children in particular are poison victims as they wish to put most anything in their mouths. Poisons should be well labeled, kept away from food and out of reach of children. Common poisons about the home are rat poisons, insecticides, kerosene, potassium permanganate, spirit, bleaching powder and numerous medicines. A child who has swallowed a poison should first be made to vomit if he has not already done so. Vomiting may be induced by having the child swallow soapy water. He should then be given as much milk and white of eggs as he can take. A doctor should be seen as soon as possible.

CHAPTER XX

THE CIRCULATORY SYSTEM

The cells of our body are nourished by nutrients carried in blood. Waste products are also carried away. Our blood is well suited for this purpose. A system of vessels and a pump assure an adequate supply of blood to all parts of the body.

About one-twelfh of our body weight is blood. About 55 % of the blood is composed of an amber-colored fluid called plasma. The rest is made up of cells suspended in the plasma. Plasma is composed of water in which are dissolved minerals, glucose, protein and waste products. The minerals help maintain proper alkalinity of blood. Glucose serves as nutrition to all cells of the body. Plasma protein has many functions. Some protein molecules are useful in the clotting of blood. Others are useful in neutralizing poisons that may accidently enter the blood. About half of the plasma protein is albumen. The albumen molecules are very small but are unable to pass through the wall of even the smallest blood vessels. In as much as the concentration of all things in solution tends to be equalized in the body, the presence of many small protein molecules in the blood tends to draw water into the blood vessels and help to maintain normal blood volume.

There are two types of blood cells, red and white. The red cells contain a red pigment called hemoglobin. Hemoglobin is capable of carrying oxygen from the lungs to cells

and carbon dioxide from the cells to the lungs. There are approximately 5,000,000 red blood cells in each cubic millimeter of blood. They are formed as circular discs that are concave on both sides. The red cells are formed in the

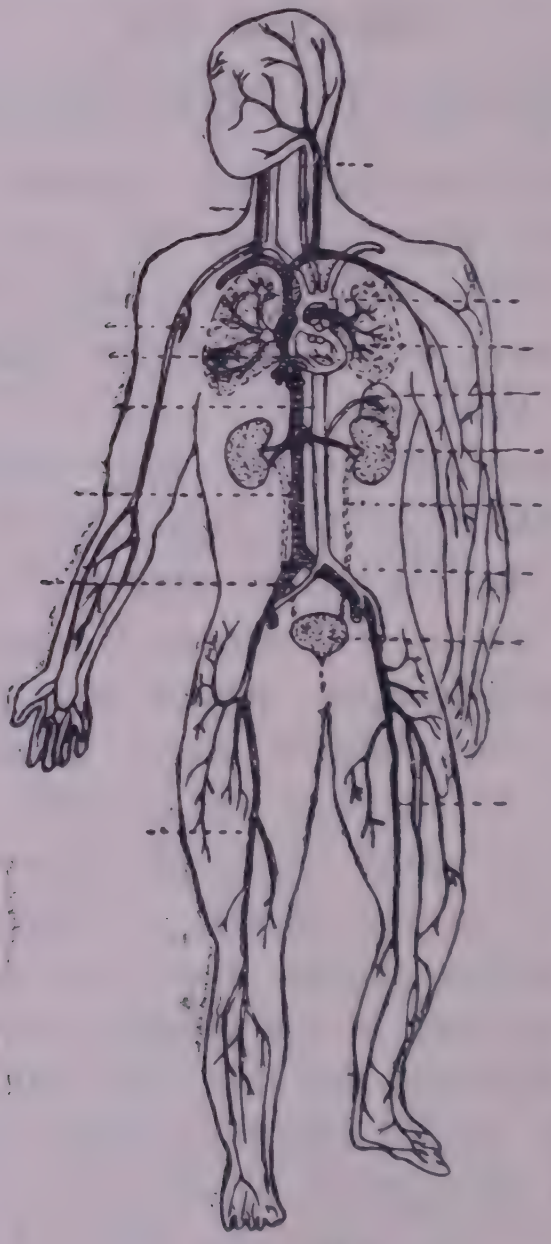


Fig. 25
The Circulatory System

center of bones, called bone marrow. They live for about one month and are then destroyed in the spleen. The pigment is taken up by the liver and gives the color to bile. The iron is used again to form new cells.

The white blood cells are somewhat larger than the red but fewer in number. There are about 10,000 in each cubic millimeter of blood. Their function is mainly concerned with fighting infection. Certain of the white blood cells are capable of eating bacteria. They may also leave the blood vessels to fight infection in the tissues. Pus is formed mainly of dead white blood cells and bacteria. Some white cells are formed in the bone marrow. Others are formed in lymph nodes.

There are also very small cells called platelets in the blood numbering about 300,000 per cubic millimeter. They are concerned with the clotting of blood. The clotting mechanism is complex and still a subject of active investigation. It is thought to function like this :

$$\text{Prothrombin} \xrightarrow[\text{calcium}]{\text{thrombokinase}} \text{thrombin}$$

$$\text{Fibrinogen} \xrightarrow{\text{thrombin}} \text{fibrin}$$

$$\text{Fibrin} + \text{blood cells} \longrightarrow \text{clot}$$

Thrombokinase is liberated from platelets which easily break up when injured. This is an enzyme which in the presence of calcium in the blood converts the plasma protein prothrombin into thrombin. Thrombin in turn acts as an enzyme to convert the soluble plasma protein fibrinogen into the insoluble fibrin. Fibrin forms threads which enmesh the blood cells and form the clot. This mechanism is essential to prevent excessive loss of blood following injury.

To assure an adequate supply of blood to all tissues, the blood is pumped by the heart through the arteries under high pressure. The heart beats about 80 times per minute. Each beat raises the pressure inside the arteries to

about the point where it would support a column of mercury 120 millimeters in height, or a column of water about 1600 millimeters in height. Between beats the pressure does not fall to zero because the smallest arteries, the arterioles, remain partially contracted permitting a limited amount of blood to pass, thus offering considerable periferal resistance. In this way pressure between beats is maintained at about 80 millimeters of mercury. It is like pumping air into a bicycle tire that is already partially inflated but has a slow leak.

The amount of blood that is distributed to the various parts of the body is regulated by the diameter of the arterioles at each place. If we are exercising a particular set of muscles, they will require more blood to carry the additional amounts of oxygen and glucose, which the tissues need for fuel. To supply this the arterioles to these muscles will dilate permitting an increased supply of blood.

After passing the arterioles the blood passes into the capillaries. These vessels are very small, just permitting the passage of blood cells. But they are so numerous

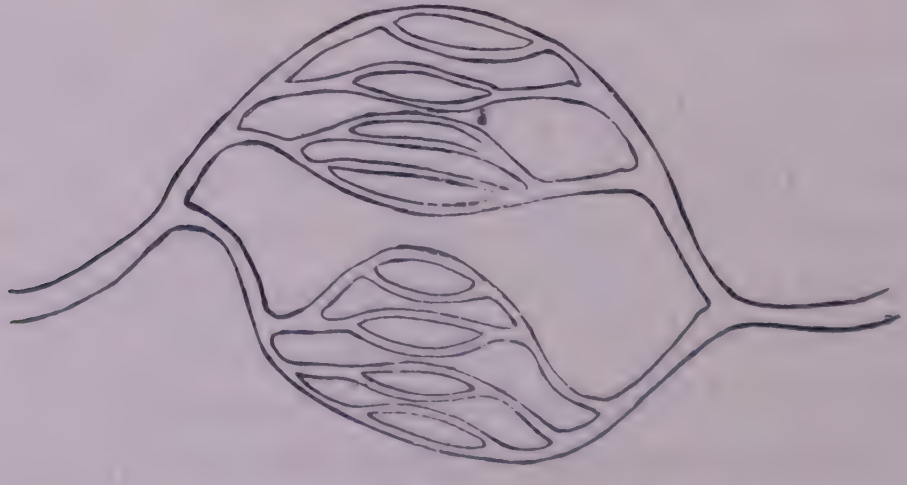


Fig. 26. The Capillaries

that the cross sectional area of these vessels is 600 times that of the aorta. For this reason blood pressure in the capillaries is very low and the blood moves slowly. It s

through these thin vessels that exchange of nutrients and waste products takes place between the cells and the blood. Oxygen and glucose pass out of the capillaries to the cells. Carbon dioxide and other waste products leave the cells to be carried away in the blood.

The blood passes from the capillaries into the veins. As it enters the veins it is under no pressure and one may wonder how the blood will return to the heart. The veins contain valves which permit the blood to flow in one direction only. As our muscles contract they exert pressure on the veins and blood is forced back to the heart in this way.

The blood enters the heart at the right auricle. This is a thin-walled chamber which weakly contracts sending the blood past the tricuspid valve into the right ventricle. The right ventricle is a thick walled chamber which pumps the blood past the pulmonary valve to the pulmonary artery and lungs. In the lungs the vessels divide into capillaries where carbon dioxide is given off to the air and oxygen is taken up. The oxygenated blood returns to the heart by the pulmonary veins to enter at the left auricle, another thin-walled chamber. A weak contraction sends the blood past the mitral valve into the left ventricle, the strongest of the four heart chambers. From the left ventricle the blood is pumped past the aortic valve into the aorta and the general circulation. These two circulatory systems, the pulmonary and the general are functioning simultaneously. That is both auricles contract at once sending blood to each ventricle. The blood carries carbon dioxide on the right side and oxygen on the left. Then both ventricles contract. The blood cannot return to the auricle because they are protected by the tricuspid

and mitral valves. The blood must exit from the pulmonary artery on the right side and the aorta on the left. After the ventricles relax blood is not permitted to re-enter

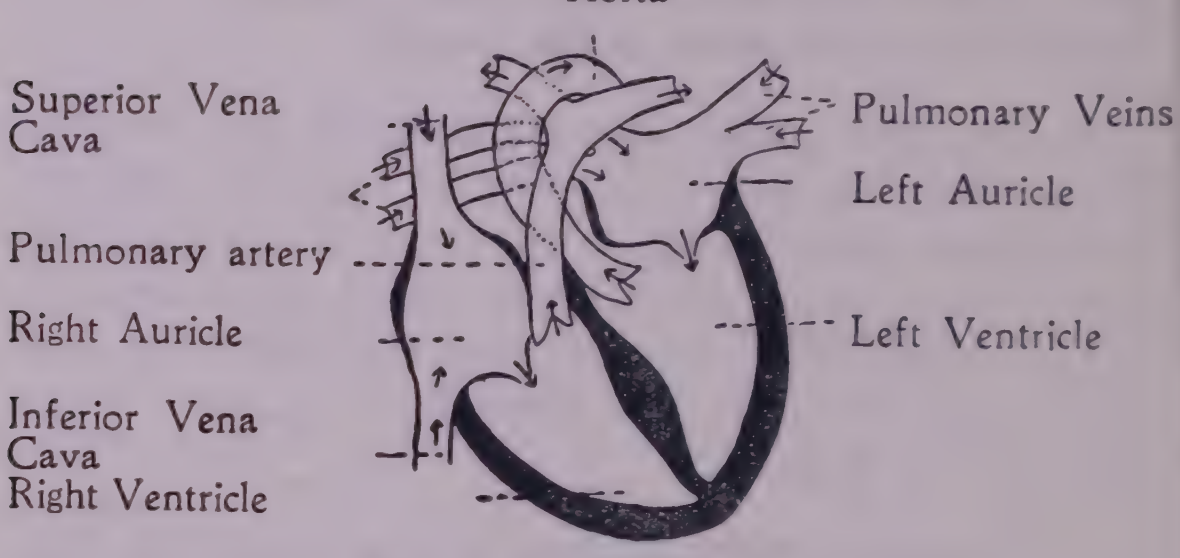


Fig. 27 The Heart

the ventricles as they are protected by the pulmonary and aortic valves. In this way the circulations proceed in one direction. The arterial side is under high pressure, the venous under low.

An additional set of vessels, the lymphatic system, returns the lymph to the blood stream. Lymph is the

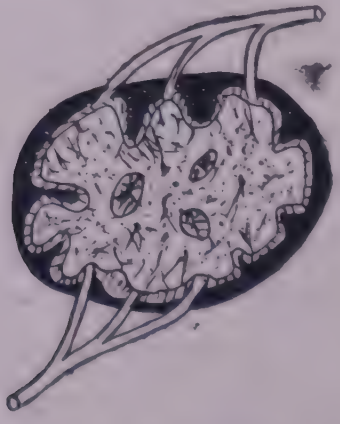


Fig. 28. A Lymph Node

fluid that escapes from the capillaries and bathes the tissue cells. Some re-enters the capillaries; the rest is

carried by lymphatic vessels. Before emptying into the veins, the lymph is filtered through the lymph nodes. Bacteria and other foreign substances are filtered out here. Occasionally the lymph vessels and nodes become infected themselves when draining an infected area. A tender red streak may then be seen leading from the infected area to the nearest lymph node. The node will be swollen and tender. If the bacteria break through this filter and enter the blood stream, the patient will develop chills and fever. He should be taken to a doctor at once.

CHAPTER XXI

WOUNDS

Wounds may be dangerous for three reasons; loss of blood, infection and loss of function. Bleeding may be from veins or arteries. Arterial bleeding is more serious because the blood is released under high pressure. This bleeding may be in spurts corresponding to the pulse. It is also lighter in color due to its oxygen content. Venous bleeding flows evenly and is dark in color. It is important to remember that arterial blood is coming from the heart and venous blood is going to the heart. A small amount of bleeding does no harm and may even serve to clean the wound. Severe bleeding may even cause death.

The first effect of blood loss is a decreased volume of circulating blood. This is associated with a fall in blood pressure. But it is the blood pressure that assures an adequate supply of blood to all tissues of the body. The most vital tissue requiring blood is the brain. In the brain are vital centers controlling respiration. If the brain is without its blood supply for even a few minutes these may be destroyed and death will occur. The body adjusts to blood loss in several ways. The heart rate is increased. Thus a smaller quantity of blood is circulated at a faster rate. The arterioles in the skin and kidneys

constrict reducing the volume of blood to these parts and thereby increasing the pressure in the remaining circulation. Thus a person suffering from severe blood loss will have a fast pulse and cold skin. They frequently sweat. This condition is known as secondary shock. If proper treatment is not given a high percentage of these patients die.

The treatment of secondary shock is first to stop the bleeding. If the bleeding is external this can be done with a pressure dressing. This consists of a thick sterile or clean piece of cloth placed over the wound and tied tightly in place. Rarely is a tourniquet needed. If a tourni-

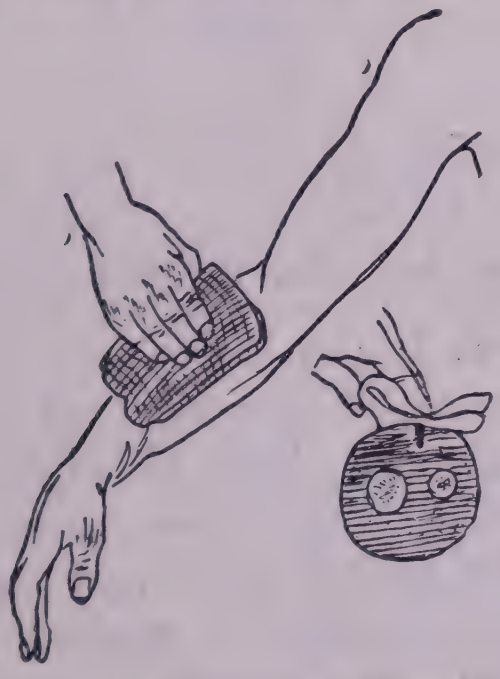


Fig. 29 Pressure Dressing

quet is used it should be made of a wide piece of cloth applied proximal to the wound and tight enough to stop the pulse periferally. Secondly the patient should be placed with his head slightly lower than his feet. In this way blood will more readily reach the vital centers in the brain. Thirdly the patient should be made comfortable. This means reassuring him all is well and protecting him from excessive cold or heat. Finally a doctor should be

called. The definitive treatment will frequently require the replacement of lost blood by transfusion. The best preven-

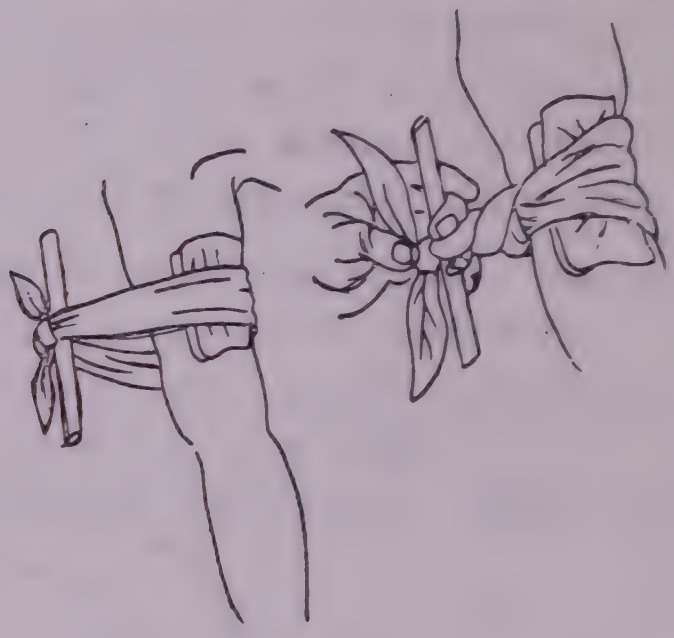


Fig. 30 Tourniquet

tion for shock is to stop severe bleeding promptly with a pressure dressing and send the patient to a doctor.

Primary shock is also known as fainting. It is due to sudden dilating of all arterioles and a corresponding drop in blood pressure. Lack of oxygen to the brain causes unconsciousness for a few moments. When the patient falls to the ground, blood again readily flows to the brain and consciousness is regained. Primary shock may be caused by fright or pain. Lowering the patient's head brings quick recovery.

Simple wounds may be adequately treated by a person trained in First Aid. The wound should be washed with soap and water and rinsed with cooled boiled water or chlorinated solution. This removes all bacteria that may infect the wound. After rinsing, a dry sterile gauze should be applied taking care not to touch the wound or that part of the gauze applied to the wound. This gauze will

prevent new bacteria from entering the wound. Sterile gauze may be prepared by wrapping square pieces of gauze in paper and sterilizing these packets by exposing them to steam for one hour. A simple method is to pack the wrapped gauze in a container. This container is placed in a drum above 2 inches of water. The

Fig. 31 A Simple Sterilizer

drum is closed and the water allowed to boil for one hour. The container is not removed until the drum has cooled.

Clean fresh wounds need not be re-dressed more than every five days. If the skin edges are widely separated they may be approximated after proper cleaning with butterfly strips of tape. These are made by cutting out triangular sections from each side of a strip of adhesive tape. The narrowed part is heated over a match to make it sterile and applied over the wound, drawing the skin edges together. Sterile gauze is then applied as usual.

The signs of infection are heat, redness, swelling and pain. The heat and redness are due to the dilated arterioles in the area which bring more blood to fight the infection. The swelling is due to increased lymph which has escaped from the capillaries. With the lymph are white blood cells capable of destroying bacteria. The

pain is due to the pressure on nearby nerves in the swollen area. Pus is formed when there is an accumulation of white blood cells and bacteria. Infected wounds

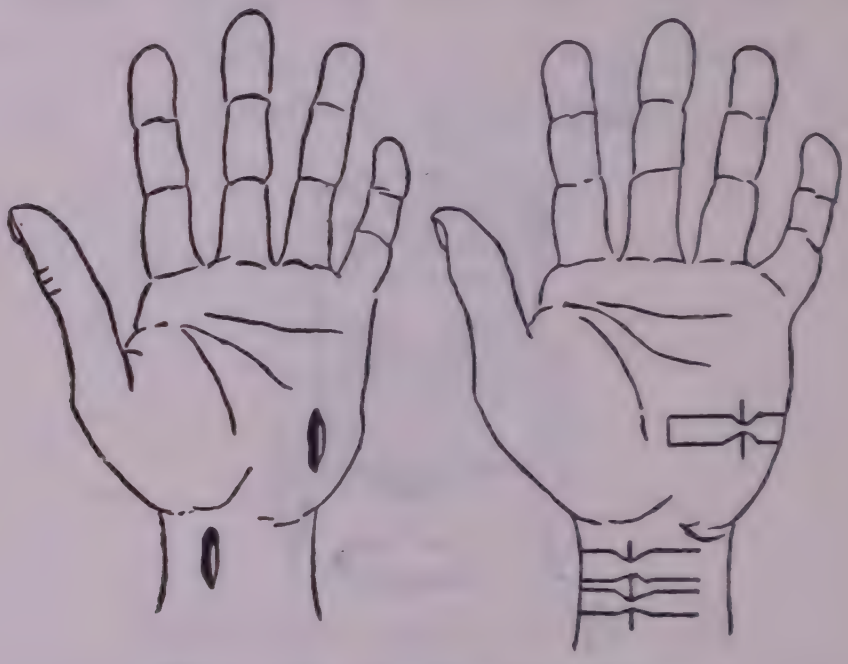


Fig. 32 Butterfly Strips

should be changed daily until there is no sign of pus. It is only necessary to wash the wound before the first dressing. No attempt should be made to close an infected wound. If fever occurs the patient should be sent to a doctor.

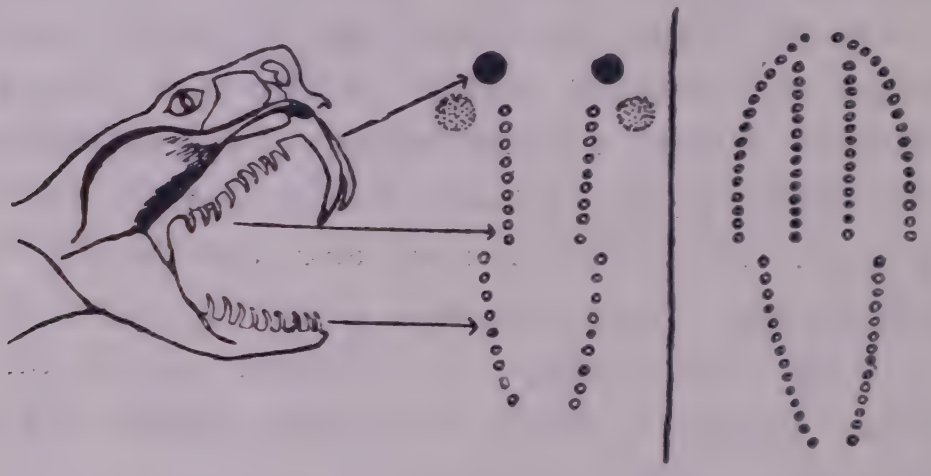
There are a few types of wounds that require special attention. A deep puncture wound is one. Drainage from these wounds is poor and bacteria that grow well without oxygen are apt to infect them. The tetanus bacteria are among the most dangerous. These bacteria produce a nerve poision causing convulsions and death in a high proportion of tetanus infections. Such wounds should always be treated by a doctor. There are two medicines used in the treatment of this disease, tetanus toxin and tetanus antitoxin. The antitoxin is made from the serum of horses that have been immunized against tetanus. When injected

it gives immediate, but temporary, immunity to the tetanus poison. It is dangerous to give the medicine more than once, as the patient may have a severe reaction. Tetanus toxin is made of the poisons produced by the tetanus bacteria, but modified so as to be safe for injection. This toxin does not cause the disease but stimulates our body to produce an immunity against the disease. It takes about 3 months to develop this immunity, so the injection must be given before injury. Usually 3 injections are given one month apart. The injection may also contain the toxins of diptheria and whooping cough, giving permanent immunity to these three diseases. It is hoped that in the not too distant future the children of village India will have the advantage of this protection.

Another type of puncture wound that may cause a particularly severe infection is the bite of a human or animal. These should be treated by a doctor. In the case of animal bites there is the additional danger of rabies, an invariably fatal disease. Fortunately the incubation period for rabies is long so that the animal, usually a dog or cat, dies before the human gets the disease. For this reason it is most important that the biting animal be captured and held for observation for 10 days. If the animal is living after 10 days, it is safe to assume it did not have rabies. If the animal was killed, it can be examined by the public health authorities to determine whether or not rabies was present. When the animal has escaped, the doctor must decide if anti-rabies injections are indicated.

Poisonous snake bites are another special type of wound the first-aider should be familiar with. It is important to be able to distinguish between the bites of poi-

sonous and non-poisonous snakes as the treatment is quite different. The poisonous snake leaves two distinctive puncture marks on the skin where its fangs injected the poisonous venom. These are absent in the bite of a



Poisonous Non-poisonous

Fig. 33 Snake Bites

non-poisonous snake. If the bite is poisonous a constricting band should be tied above the bite to stop the veinous blood from spreading the poison to the rest of the body. The arteries should not be occluded. This is not a tourniquet. It is then necessary to make cross incisions about one-quarter inch deep over the fang marks with a knife or razor blade that has been flamed over a match. The blood and lymph containing the venom is then sucked out by mouth or breast pump. The patient should then be taken to a doctor for an anti-venom injection.

CHAPTER XXII

THE SKIN

The skin is a special form of epithelial tissue. It serves as a protective covering. But it is more than this, having many functions necessary for life. The skin may be thought of as an important organ of the body. It is concerned with the perception of pain, touch, heat and cold, through special sensory nerve endings. It helps regulate blood pressure by the degree of constriction of its arterioles. It is the most important factor in the regulation of body temperature. Certain waste products are eliminated in the sweat. Oily secretion called sebum from the sebaceous glands keeps the skin soft. The skin absorbs oils and forms vitamin D when exposed to sunlight.

The skin is composed of two layers, the epidermis and the dermis. The epidermis is composed of several layers of dead cells which are germinated by a basal layer of epithelial cells. There are no blood vessels in the epidermis. The basal layer is nourished by vessels from the underlying dermis. The epidermis also forms the hairs, in projections of basal cells into the dermis called hair follicles.

The dermis is composed mainly of connective tissue in which are imbedded a rich supply of blood vessels,

special nerve endings, sweat and sebaceous glands. Ducts of the sweat glands pass through the epidermis. Sebum is discharged through the hair follicles.

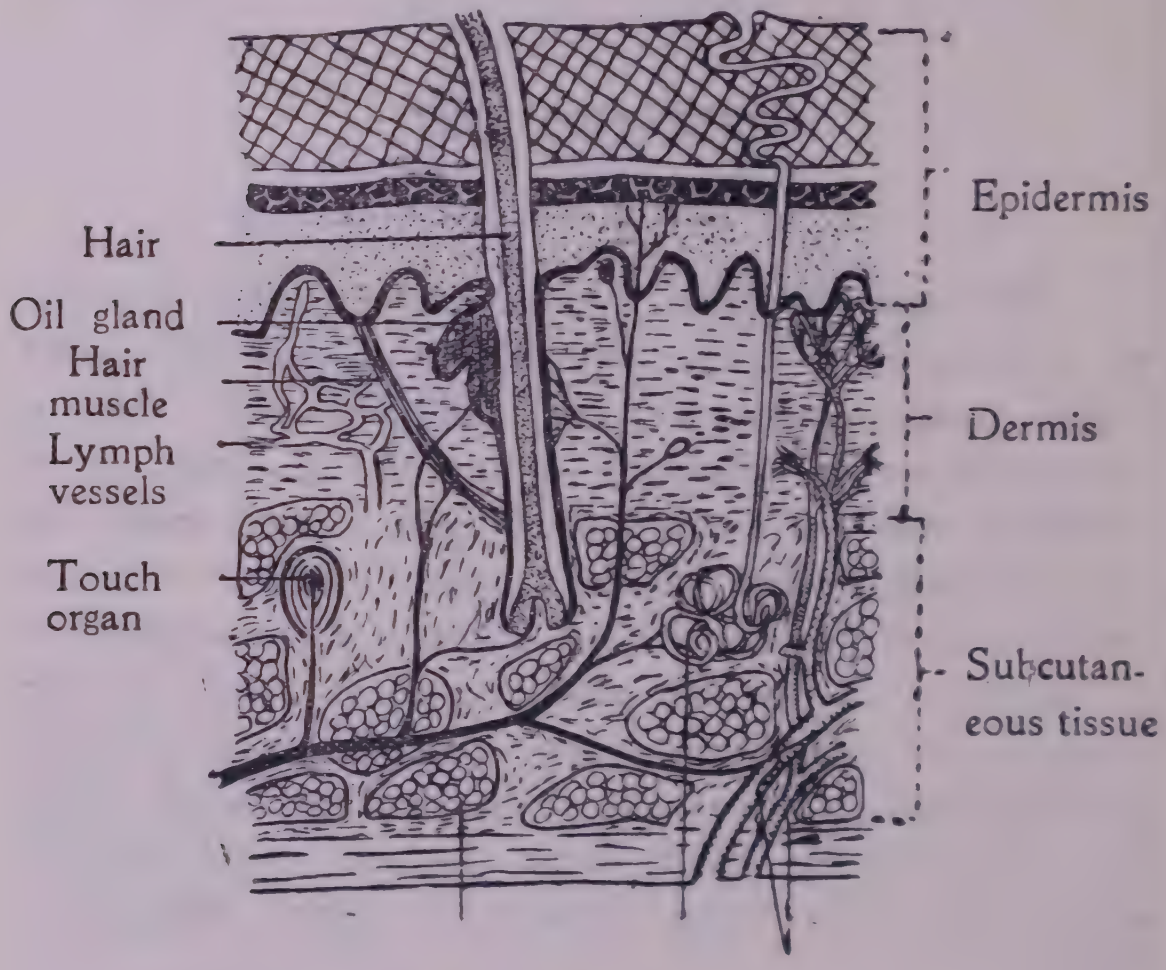


Fig. 34 The Skin

Our body temperature is held within narrow limits by a temperature regulating center in the brain. Orally it varies little from 98.6 Fahrenheit. The rectal temperature is about one degree higher. Our brain sends messages by way of nerves to the arterioles and sweat glands in the skin. If heat is to be released the arterioles dilate making the skin warm and the sweat glands moisten the skin and cool it by evaporation.

Occasionally in a hot climate this mechanism fails. The skin remains dry and the temperature rises to about 107. The condition is known as heat stroke. The patient generally becomes unconscious. If the temperature is not brought down within a few minutes, the brain may be permanently damaged. Thus when a person loses consciousness on a hot day and has dry skin and a high temperature, his body must be cooled immediately. Use should be made of whatever is available. Soaking his clothes with cold water is quite effective. After treatment is started a doctor should be called.

A different but related condition is heat exhaustion. This is caused by excessive loss of salt in sweat. It is frequently preceded by muscle cramps. The patient may lose consciousness. His skin is moist and his temperature normal or only slightly elevated. The treatment is the administration of salt, and treatment for shock.

The most serious injuries to the skin are burns. These are classified as first, second and third degree. A first degree burn is superficial causing only redness. This is caused by dilation of the arterioles. In second degree burns a blister forms. This is due to loss of plasma between the dermis and epidermis from destroyed capillaries. As long as the dermis is living a new epidermis will be formed. But in third degree burns both the epidermis and dermis are destroyed. The skin appears pale because the blood vessels have been completely destroyed. Also the third degree area is not painful as the nerves have been destroyed. This burn will leave a scar, as it heals with connective tissue instead of epithelial tissue.

The treatment of burns depends upon their degree and extent. Small first degree burns require no treatment.

The treatment of even small second degree burns is best done by a physician. These injuries are easily infected, and an infection may destroy the underlying dermis, and convert the burn to third degree. If carefully washed and rinsed with sterile water and a sterile dressing applied, the burn should heal in a week or two. When the burn covers over 25% of the body surface there is always the danger of shock due to loss of plasma from the blood. If the burn is over 50% shock is inevitable unless blood or plasma is transfused. Such burns should be covered with a sterile dressing or clean cloth and the patient transported immediately to the nearest hospital.

The first aid treatment of third degree burns is the same as second. Even small burns, however, will not heal without scar unless covered with a skingraph. This consists of a thin layer of skin taken from another part of the patient's body which is used to cover the burn. Thus all third degree burns should be treated by a physician. If over 25% of the body surface is involved, the patient should be removed immediately to the nearest hospital that can give a blood transfusion. Blood donors should accompany the patient.

CHAPTER XXIII

THE NERVOUS SYSTEM

The nervous system resembles a telephone system. As a telephone system links together the various parts of the country, so the nervous system brings the various parts of the body in touch with each other. It also keeps us in contact with the outside world.

The nervous system is divided into two parts; the central nervous system and the peripheral nervous system. Most connections between nerves are made in the central nervous system, consisting of the brain and spinal cord. Nerve bodies make up the grey matter and the axons the

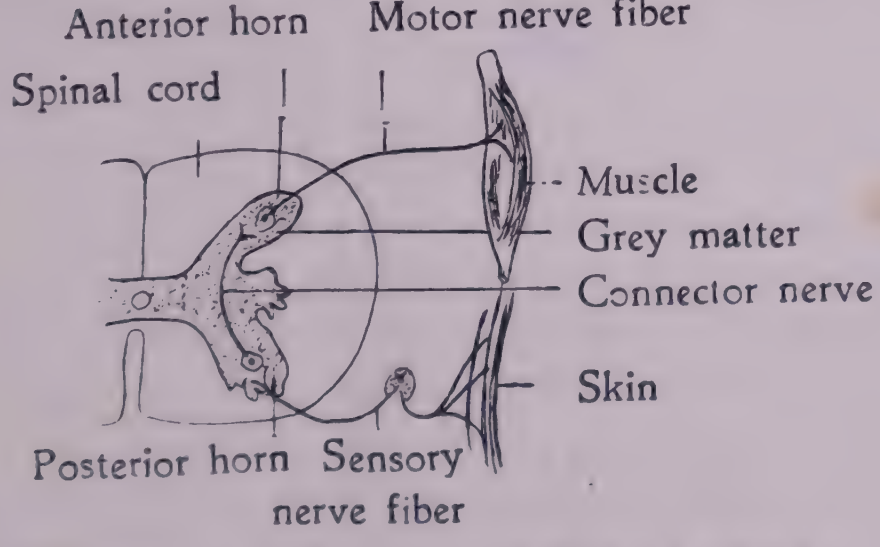


Fig 35 Transverse Section of Spinal Cord

white matter of these structures. They are enclosed in the skull and vertebral column where they are surrounded

by a clear fluid, the cerebro-spinal fluid. The axons of sensory and motor nerves make up the periferal nervous system. The cell bodies of the motor nerves lie in the anterior horn of the grey matter of the spinal cord. The cell bodies of the sensory nerves are contained in the posterior root ganglion which lies just outside the spinal cord but within the vertebral column. The sensory and

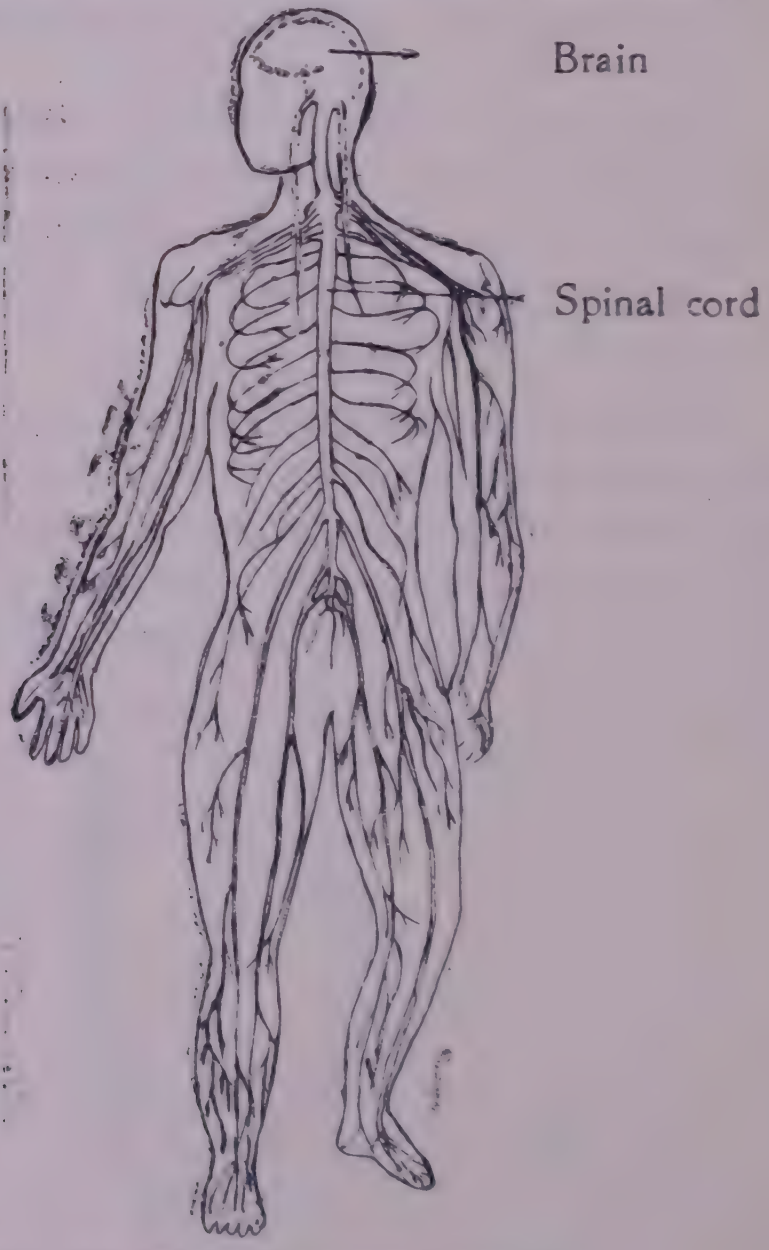


Fig. 36 The Nervous system

motor fibers enter and leave the spinal cord separately at each vertebral segment, but are seen joined together as the peripheral spinal nerve before leaving the vertebral column.

The simplest illustration of the functioning of the nervous system is a reflex. An example is the automatic withdrawal of the hand when a hot object is touched. At least three neurones are needed to complete this circuit. The first is the sensory neurone with its cell body in the posterior root ganglion, its dendron connecting with a sensory ending for pain in the skin and its axon leading to the posterior horn of the spinal cord. The pain stimulus travels in the form of an electrical impulse over this sensory nerve from the skin to the spinal cord. In the posterior horn the cell body of a connecting neurone is contacted whose axon carries the stimulus to the cell body of the motor nerve located in the anterior horn. From here, the stimulus is carried to the muscle of the arm, which contracts withdrawing the hand.

It will be noted that this reflex occurs without thinking and examination of the nerves involved shows no connection with the brain. It is possible for the same motion of the arm to occur without a stimulus to the hand. This occurs in voluntary acts. A neurone from the brain with an axon extending down the spinal cord may make contact with the same motor neurone in the anterior horn. The neurones extending from the brain to the anterior horn cells of the spinal cord are known as upper motor neurones. The neurone from the spinal cord to the muscle is called the lower motor neurone. In paralysis due to stroke the upper motor neurone is destroyed by damage to the brain. In the infectious disease poliomylitis paralysis is caused by destruction of the lower motor neurone in the anterior horn. Reflexes are destroyed in poliomylitis but preserved in stroke.

The stimulus at the skin, besides being sent to the motor neurone, makes connection in the posterior horn

with neurones to the brain. In this way the stimulus at the skin is perceived as heat and pain by the brain.

An additional nervous system exists known as the autonomic nervous system. The nerve cells for this system arise from ganglia which are situated mainly just outside the vertebral column. They make connections with the central nervous system and with the internal organs and blood vessels. They control the involuntary movements and secretions of the internal organs as well as the degree of contractions of the arterioles. Centers in the brain regulate these activities.

Nerves within the central nervous system once destroyed never regenerate. Injuries to nerves outside the central nervous system may heal with return of function. This fact is of importance in first aid care of spine injuries.

CHAPTER XXIV

THE EYE

The eye is constructed like a camera having a shutter, diaphram, lens and photographic plate. Instead of recording the picture that is brought in focus on film the picture is carried over the optic nerve to the brain for perception.

The eyeball is protected in a socket of bone. It moves freely in this socket by the action of six small

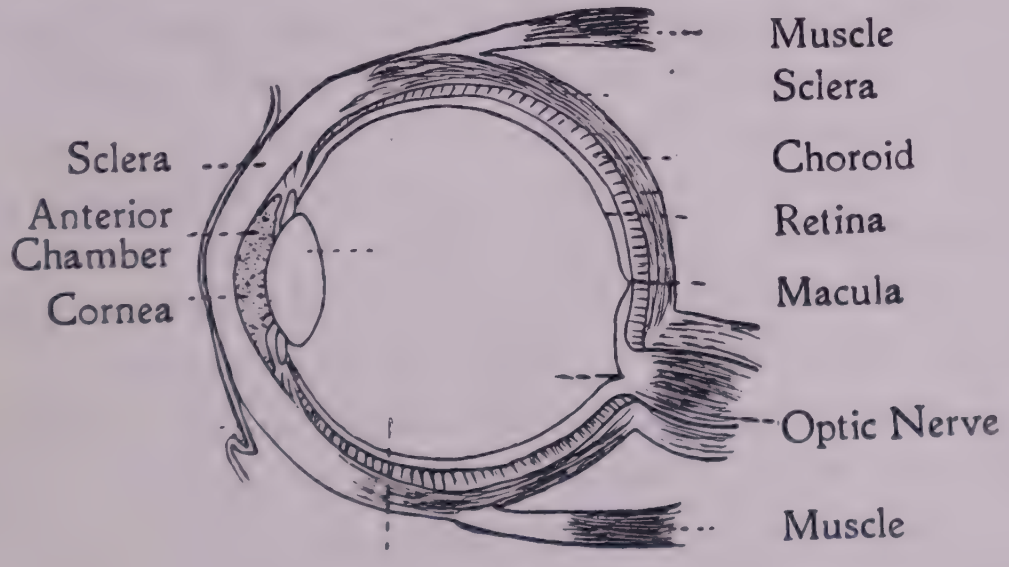


Fig. 37 The Eye-ball

muscles attached to bone and its outer tough coat, the sclera. The sclera forms the white of the eye and is continuous with transparent window in front, the cornea.

Light rays pass through the cornea and the clear liquid in the anterior chamber known as the aqueous humor. The amount of light permitted to enter the lens is limited by the iris which is a continuation of the vascular, or blood vessel, coat of the eye, the choroid. The iris and choroid coat are pigmented giving color to the eye. This pigment may be brown, green, blue, grey etc. The round opening in the iris that admits light is the pupil. It appears black in humans, because little light is reflected back out of the eye, as the interior is dark due to the pigmented choroid. The pupil is large in the dark to admit more light, and small in sunlight to limit the amount of light entering the eye. The size of the pupil is determined by small muscles in the iris. They respond reflexly to light. Between the lens and the iris is the small posterior chamber. The aqueous humor is produced by the ciliary body and first enters the posterior chamber. It circulates around the iris to the anterior chamber where it is reabsorbed into the blood stream in a small vein at the angle of the cornea and iris. If this vein closes, aqueous humor accumulates in the anterior chamber increasing the pressure within the eyeball. This condition is called glaucoma and is one cause of blindness.

As the light rays pass the lens they are bent and brought to focus on the retina. This process is known as refraction. On the retina an image of the outside world is transmitted over the optic nerve to the brain. Occasionally in old age the lens become opaque. This is known as cataract. The defective lens may be removed surgically to permit passage of light once again. After the removal of a lens a patient must wear glasses to focus light on the retina.

The center of the eyeball is filled with a jelly-like substance called the vitreous humor. If this fluid is lost

in an eye injury it cannnot be replaced. The first aider may have an opportunity to save the vision of some person by preventing loss of this valuable fluid. Eye injuries should be lightly covered with sterile gauze and the patient transported in a strecher, face up, to a doctor.

In the normal eye light is focussed on the retina at its most sensitive part, the macula. Some adjustment can be made in the point of focus by changing the shape and refractive power of the lens. This adjustment is known as accommodation. Small muscles in the ciliary body can make this change in shape of the lens. Unfortunately the adjustment cannot be made by all people. In some the light rays come to focus behind the retina. These people are far sighted. In others the rays come to a focus in

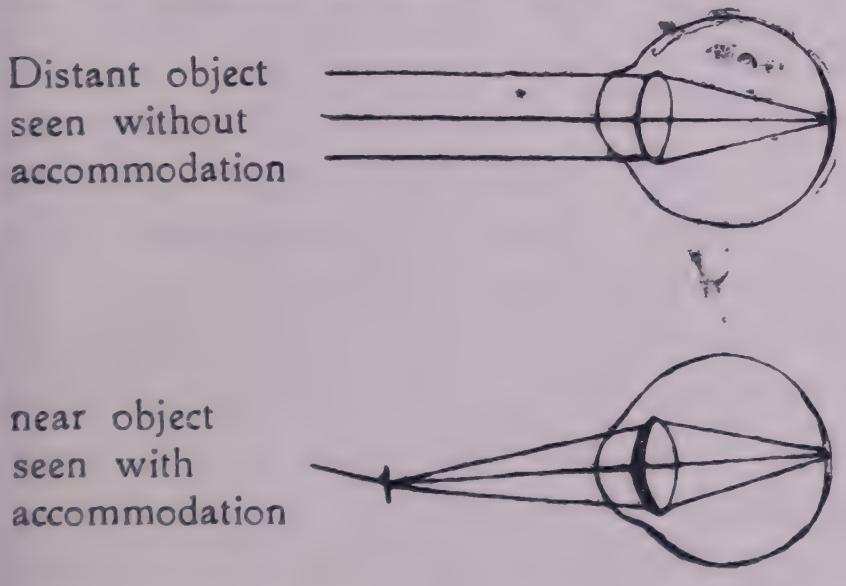


Fig. 38 Accommodation

front of the retina. These people are near sighted. Both conditions can be improved by proper glasses.

Vitamin A is necessary for the proper functioning of the retina. Deficiency of vitamin A in the diet causes night blindness.

The eyelids serve to protect the cornea. The inner aspect of the lids and the white of the eye are covered

with a thin membrane, the conjunctiva. The upper lid contains a hard plate, the tarsal plate. Above this plate is a tear, or lacrimal gland. Moisture secreted by this gland helps wash the surface of the cornea and keep it from becoming dry. The lacrimal glands secrete the tears through the tarsal plate by several small ducts.

Foreign bodies on the cornea or conjunctiva cause an irritation that produces increased secretion, which helps wash the irritant out. The tears may leave the eye over the lower lid or pass into the nose by way of the lacrimal sac and nasolacrimal duct. If this fails to remove the foreign body the first aider should wash his hands and examine the eye to see where it is located. When on the cornea the patient should be sent to a doctor. If on the sclera it may be gently removed with a bit of cotton. The lower lid may be inspected by having the patient look up and gently pulling the lid down. Inspection of the upper lid requires turning the tarsal plate. But many foreign bodies may be removed from the upper lid by having the patient look down and gently pulling the upper lid over the lower. In this way the lower lid wipes the inner surface of the upper lid. It is best to leave imbedded foreign bodies for a doctor to remove. Liquid or powdered irritants should be washed out of the eye with plenty of water.

Infection of the conjunctiva, called conjunctivitis, is a common disease of our villages. It is due to vitamin A deficiency and the prevalence of flies. The vitamin deficiency makes the eye susceptible to infection, flies transfer the infection from one person to another. Children are particularly affected. Infection of the cornea, or keratitis, is more painful and more serious. If this infection

is not treated early, a white scar may develop, which makes the cornea opaque and the eye useless. All eye infections should be promptly treated by a doctor.

All school children should have their vision tested. Those complaining of headache, and those doing poorly in reading, should be suspected of having a refractive error. They may be greatly benefited by glasses.

CHAPTER XXV

THE EAR

The function of the ear is hearing. Sound consists of vibrations of the air called sound waves. The ear transmits these vibrations to the auditory nerve. Stimulus to this nerve is carried to the brain where it is perceived as sound.

The ear is divided into external, middle and inner parts. The external ear consists of the pinna which helps

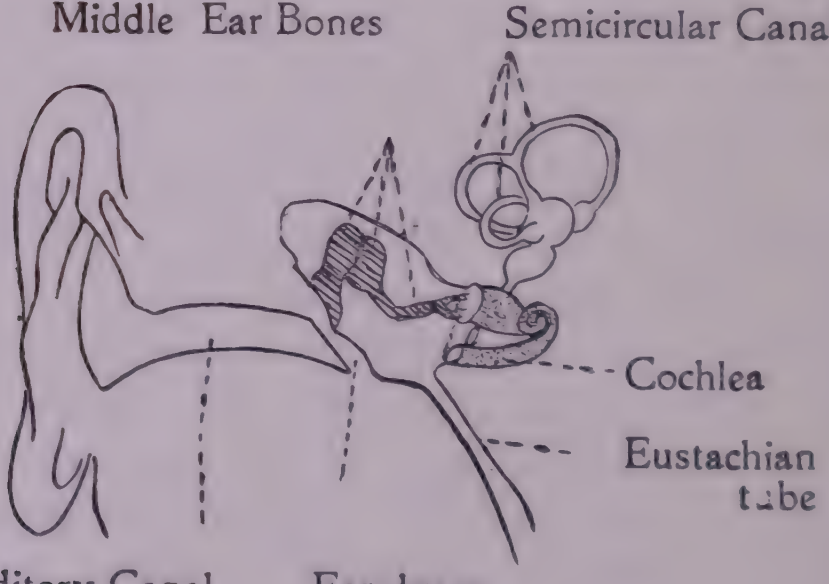


Fig. 39 The Ear

collect sound waves. These vibrations are directed through the external auditory canal to the ear drum. This drum separates the external from the middle ear.

The middle ear is a cavity, the tympanic cavity, in which are located three small bones. These bones are linked together to transmit the sound waves from the ear

drum to the inner ear. The Eustachian tube connects the tympanic cavity with the nose. This tube is generally closed except when we swallow. As it opens, the air pressure inside the tympanic cavity becomes equal to the pressure outside.

The inner ear is imbedded in bone. It is composed of fluid filled spiral canals, called the cochlea. Sound vibrations are transmitted from the ear drum to this fluid by the three small bones in the middle ear. The vibrations in the cochlea stimulate, the auditory nerve, which carries nerve impulses to the brain, where they are perceived as sound.

Closely associated with the inner ear are a group of three semicircular canals in the same bone. These are also filled with fluid. They are concerned with the sense of position of the body. Each of the semicircular canals lies in a different plane at right angles to the other. Movements of fluid in these canals stimulate another branch of the auditory nerve, and the impulses are carried to the brain, where they are perceived as change in the position of the head.

The ear drum is a thin membrane. Damage to this membrane may cause permanent impairment of hearing. It is for this reason that it is not advisable to put any object in the external auditory canal. Wax and foreign bodies should be washed out with water. Wax may be first softened with a few drops of hydrogen peroxide. A small amount of wax does not impair hearing and even serves to protect the skin in the external auditory canal. Imbedded foreign bodies should be removed by a doctor.

Pain or discharge from the ear generally means infection. The infection may be either in the external ear or

the middle ear. The two conditions are quite different. Infection of the middle ear comes from the nose by way of the Eustachian tube. It is therefore generally associated with the common cold. The infection also involves the lining of the Eustachian tube which becomes swollen and closed off. Pus forming in the middle ear is then unable to escape, and exerts pressure on the ear drum. This causes pain, and there is usually fever. If not promptly treated the drum will burst and pus will drain out of the external auditory canal. This will certainly result in decreased hearing and the drainage may continue for many years. Obviously, this is a serious infection. It occurs more frequently in children. A person who has recently had a cold and now has pain in the ear with fever should be given prompt treatment by a doctor. The best prevention for this condition is to use a type of nose drops during a cold that will shrink the lining of the nose and Eustachian tube. One quarter per cent ephedrine will do. In this way, pus will drain out of the Eustachian tube, instead of through the ear drum.

Drainage from the ear, without fever or a recent cold, generally means infection in the external auditory canal. Cleaning the ear with hydrogen peroxide and daily use of spirit ear drops is quite effective treatment. It may take two to three weeks to cure resistant cases. The advice of a doctor is always desirable.

Partial loss of hearing is frequently mistaken for low intelligence in school children. Children who are not progressing well or are presenting behavior problems should have their hearing checked. A simple method is to find out at what distance the child can hear the tick of a watch, and compare it with a person with normal hearing.

CHAPTER XXVI

THE SKELETAL SYSTEM

The function of the skeletal system is to give support and protection to the body. The head and trunk include 74 bones; the limbs 126. With the six small bones in the middle ears the total comes to 206.

The skull is divided into the cranium, which is a closed sphere, and the bones of the face. In the infant not all the bones of the cranium are fused. Thus, a soft spot can be felt in the front and in the back of the head. By eighteen months these are generally closed. The cranium contains and protects the brain.

The skull rests on the vertebral column. This consists of 33 vertebral bones. The column is flexible. The spinal cord continues from the brain through the neural canal of the vertebrae. Between each two vertebrae a pair of spinal nerves is given off from the spinal cord.

The first 7 vertebrae form the neck. The next 12 support the thorax, each connecting with two ribs. The next 5 are the lumbar vertebrae forming the small of the back. The next 5 are fused forming the sacrum. The last four are fused to form the coccyx or tail.

The upper limb is attached to the trunk by the clavicle and scapula. These form a shallow socket in which the humerus moves freely. The ulna forms the main bone

of the forearm at the elbow joint, whereas the radius is the main bone in the wrist joint. Eight carpal bones form

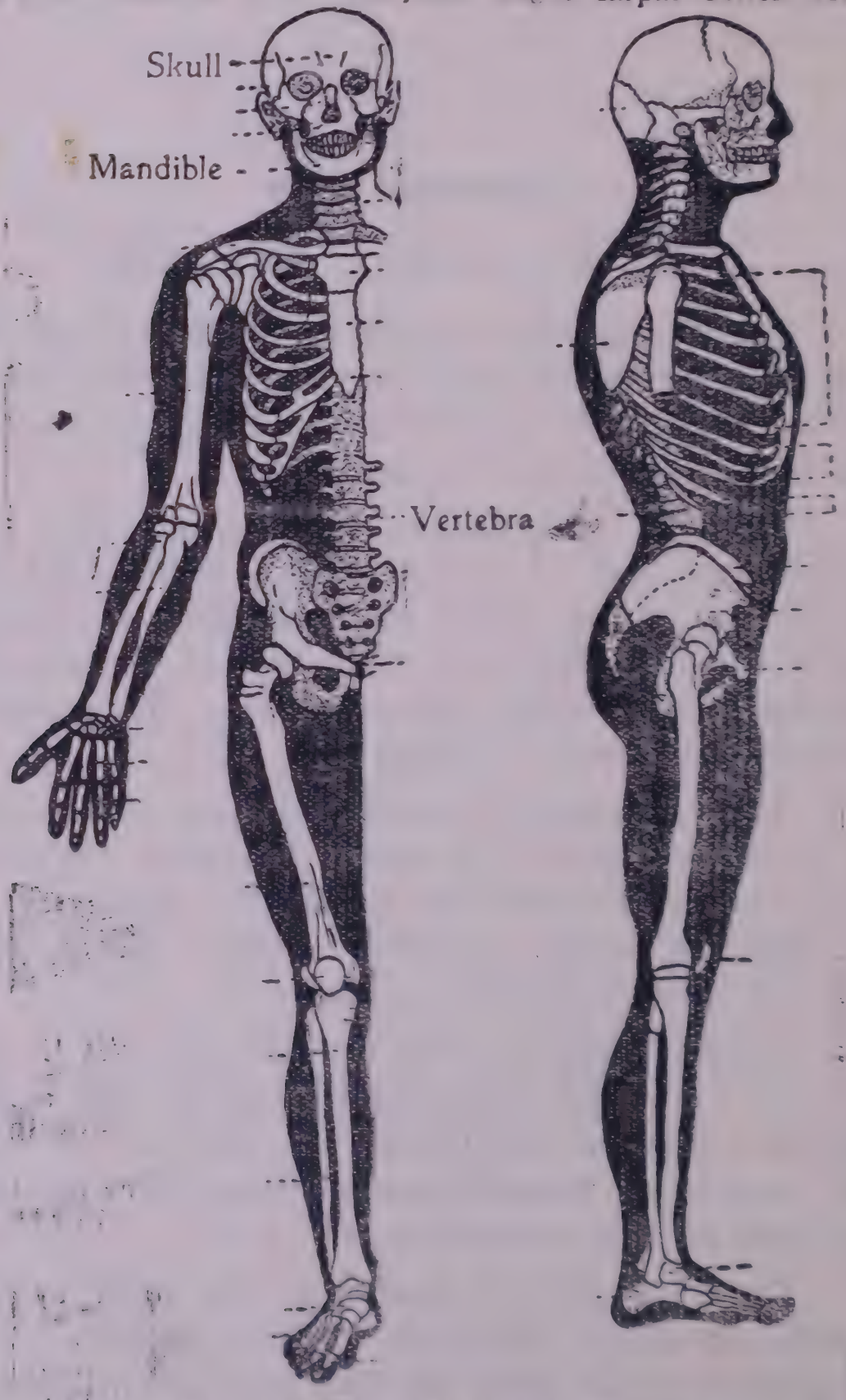


Fig. 40 The Skeletal System

the wrist, 5 metacarpals the hand, and 14 phalanges the fingers and thumb.

The bones of the lower limb are connected to the trunk by the pelvic girdle. This girdle incorporates the sacrum. On each side three bones fuse to form a deep socket for the femur to rotate in. The femur meets the tibia at the knee joint. The patella, or knee cap, is a bone developed in the tendon of a large thigh muscle. The fibula is not important for weight bearing but serves as a place of attachment for many muscles. The ankle is formed mainly by the tibia and talus. The fibula forms the lateral portion. Besides the talus there are six other tarsal bones. The calcaneum forms the heel. The others contribute to the arch of the foot. The five metatarsal bones complete the arch, and 14 phalanges form the toes.

Fractures of these bones are classified as being simple or compound. In simple fractures there is no break in the skin. In compound fractures the skin is broken, and the danger of infection exists. Infections of bone are very difficult to cure. For this reason all compound fractures must receive prompt medical attention. A sterile gauze over the wound will prevent additional bacteria from entering it.

Fractures of the skull are important mainly for injury to the brain. In skull fractures there is usually a blow to the head followed by unconsciousness, and watery or bloody discharge from the nose or ear. If these symptoms are present the patient should be hospitalized. Or, if there is a break in the skin or a depressed area, the patient should be taken to a doctor. More commonly the child falls and is momentarily unconscious without any other evidence of injury. This child should be observed for evidence of brain damage. The common symptom is

drowsiness. The child loses interest in play and may sleep more than usual. The other thing to watch for is weakness of any muscle. Inequality of the pupils or inability to walk or use an arm are examples. If any of these develop the child should be taken to a doctor. On the other hand, if the child is playing normally a few hours after the injury he probably has no brain damage. It is best to place him on limited activity for one week. The slow onset of symptoms of brain damage is due to the fact that it generally involves a tear in a blood vessel. It takes time for a clot to form and cause pressure on part of the brain. The clot also causes general increased pressure inside the cranium, as the cranium is a closed space with no possibility of expansion.

Fractures or dislocations of vertebrae usually occur following a fall. Again the danger is nerve injury, or damage to the spinal cord. It will be remembered that nervous tissue within the central nervous system does not regenerate when injured. It is therefore important that back injuries are treated so as not to increase any injury

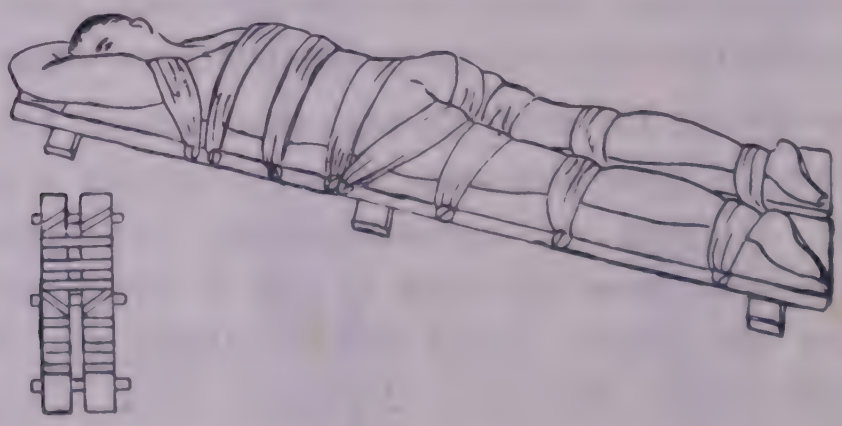


Fig. 41 Splinting a Fractured Spine

to the spinal cord. Damage to the spinal cord will be increased by flexion of the spine, that is, bending forward. As long as the back and neck is arched in extension, no

further damage will occur. A patient with a back injury, where fracture is suspected, should be moved to a hard flat surface, as a board, door or wooden bed. Care must be taken not to allow the spine to flex at any time. A folded blanket may support the small of the back. A second blanket may support the neck.

Fractures of extremities require splinting for first aid

Fig. 42 Splint for Fractured Femur

treatment to prevent injury to nerves and blood vessels,

Fig. 43 Splint for Fractured Tibia

or the possibility of converting a simple fracture to com

Fig. 44 Splint for Fractured Ankle or Foot

pound. In fractures above the wrist and ankle, the splint

should immobilize the joints above and below the fracture, Thus fracture of the femur requires immobilization of the hip and knee joints. The splint must extend from the shoulder to the ankle. Fracture of the tibia requires a splint the length of the lower extremity. Fractures of the ankle or foot may be wrapped in a pillow.

In fractures of the humerus the arm should be splinted and fixed to the chest. The forearm is placed

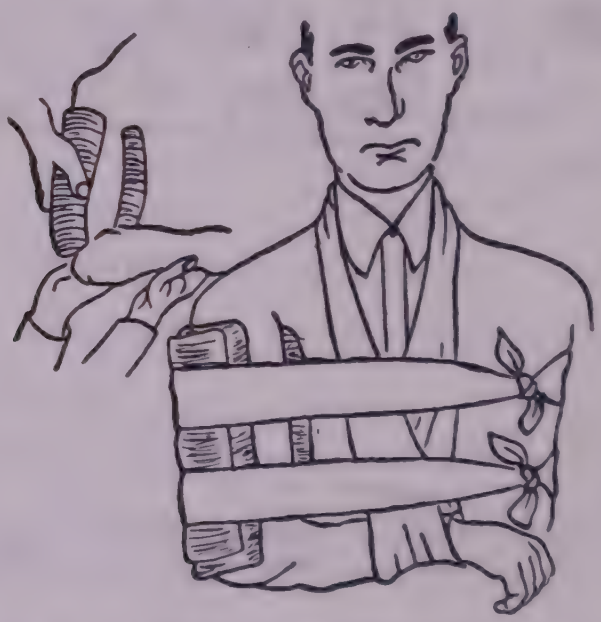


Fig. 45 Splint for Fractured Humerus

in a sling. Forearm and wrist fractures require a splint

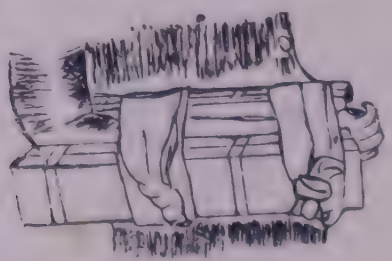


Fig. 46 Splint for Fractured Forearm or Wrist

from the hand to the elbow. The patient will be more comfortable wearing a sling.

Splinting material should be well padded. Do not move the patient until splinted. Never try to set a fracture.

The movable joints are strengthened by strands of fibrous tissue called ligaments and by a fibrous capsule. In sprains these supporting structures are torn. Such injuries should be splinted by the first aider to immobilize the involved joint and the patient sent to a doctor.

Dislocations of joint are difficult to distinguish from fractures. The first aid treatment is the same as in fractures.

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CHAPTER XXVII

THE MUSCULAR SYSTEM

Muscles attached to the skeletal system are under voluntary control. Their main function is to move the various parts of the body. As the muscle inserts in bone it generally forms a fibrous tendon. The tendon crosses a joint, forming a lever. If attached near the centre of the

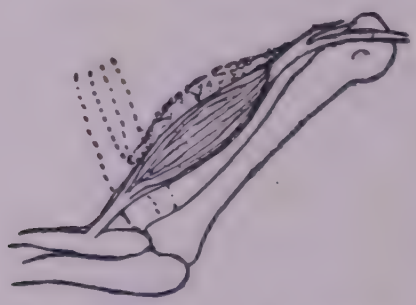


Fig 47 The Muscle as a Lever

joint, it gives wide motion but little power. Attachments away from the joint give more power but less motion. Tendons to the fingers are long, permitting the fingers to be thin and capable of fine manipulations. The ability to oppose thumb to the four fingers is responsible for many of man's achievements.

Muscles respond to exercise by becoming larger and stronger. In This way we adapt to our daily work. Unusual activities are frequently followed by muscle pain. Muscles that are not used regularly tend to degenerate.

Strains follow severe exertions, and cause small tears in the muscle or tendon due to overstretching.

Strains can be avoided by proper use of muscles. The most common cause of strain is lifting an object from

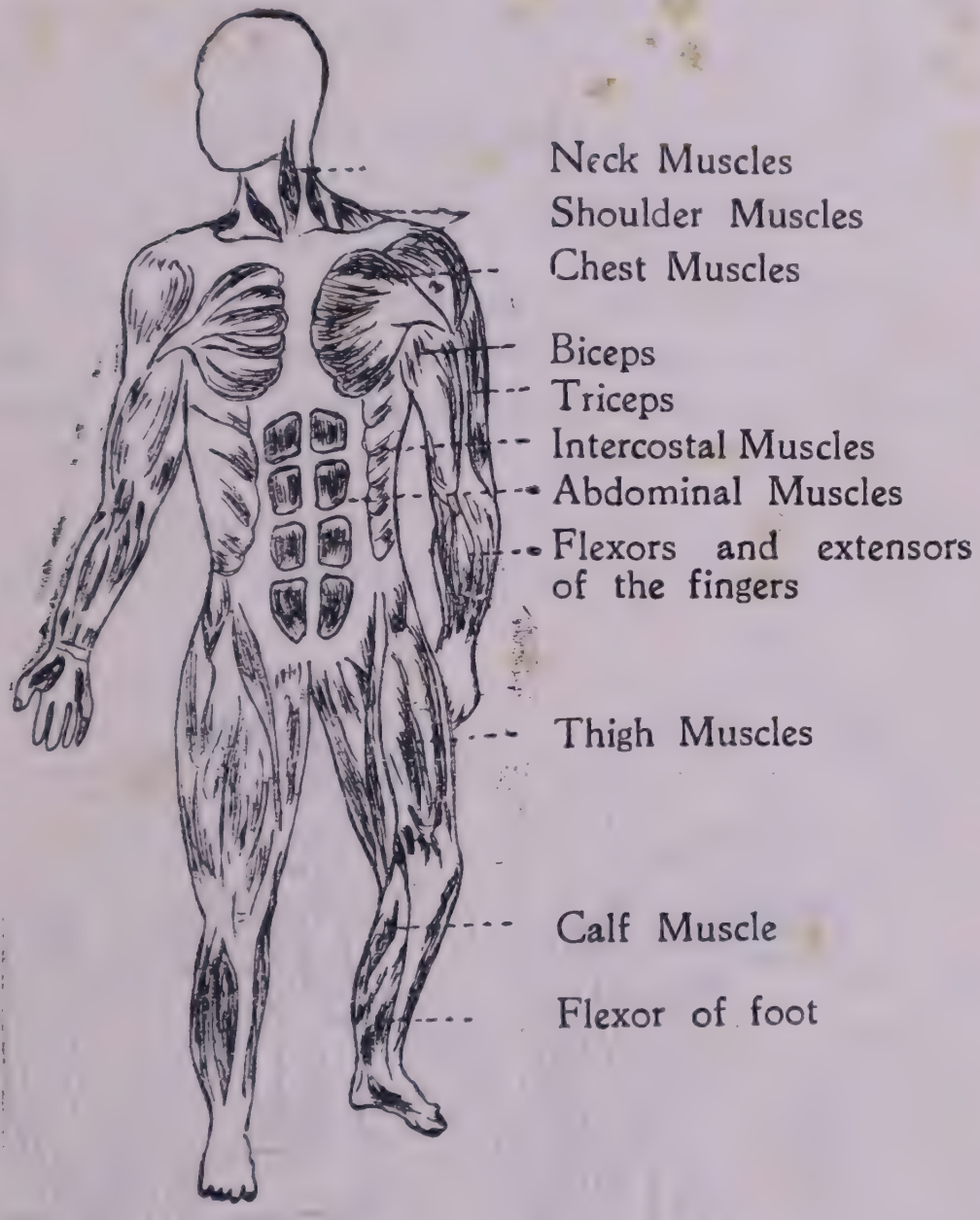


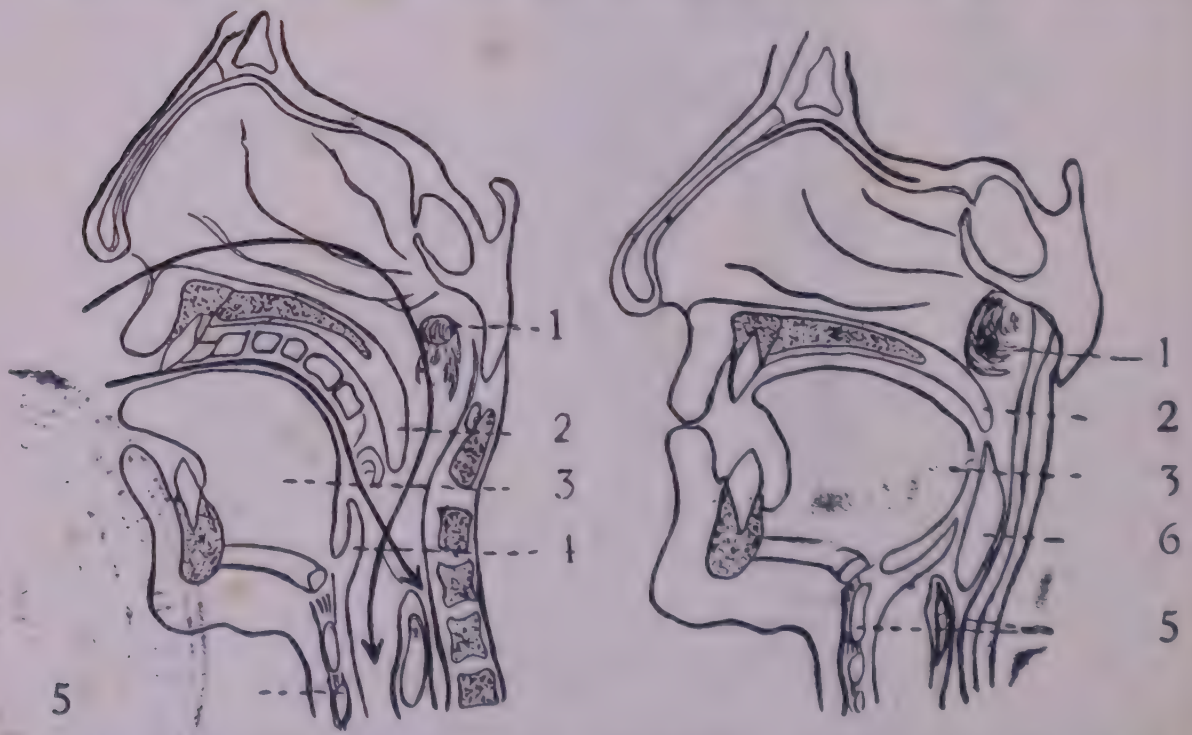
Fig. 48 The Muscular System

the wrong position. Attempting to lift too great a weight too fast is another. Back strain can be avoided by using more powerful leg and thigh muscles in lifting, instead of back muscles. The strained muscle should be rested. Heat gives relief of pain. Gentle massage is also helpful.

CHAPTER XXVIII

THE RESPIRATORY SYSTEM

The function of the respiratory system is to provide a supply of oxygen for the blood, and to relieve the blood of its load of carbon dioxide. This is accomplished by rythmical respiratory movements, which continuously bring fresh air to the pulmonary capillaries. This is external respiration. Internal respiration involves the exchange



1. Opening to the eustachian tube. 2. Soft palate 3. Tongue 4. Epiglottis 5. Larynx 6. Food

Fig. 49 The Nose and Throat

of oxygen and carbon dioxide in the tissues. External respiration begins with the nose.

The nose is an air conditioner. As air passes through the nose it is filtered through hairs, warmed by a rich supply of blood vessels, and moistened by a large moist surface. The air is prepared in this way for the lungs.

The nose is also the center for the sense of smell. The olfactory portion of the nose is supplied with special cells which are stimulated by inhaled gases or small particles. These cells transfer the stimulus to the olfactory nerve and then to the brain where it is perceived as smell. Small filaments of the olfactory nerve enter the nose by piercing a thin plate of the skull.

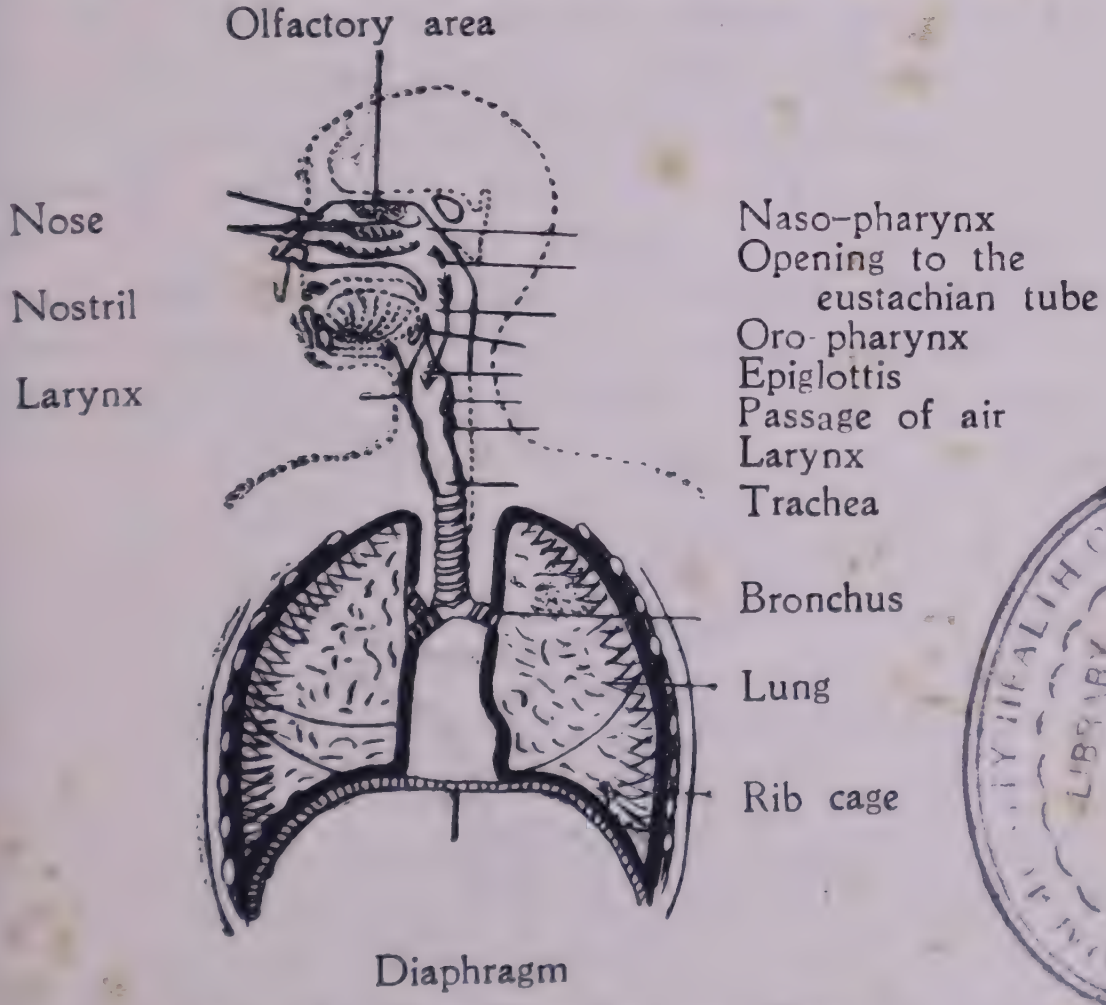


Fig. 50 The Respiratory System

The nose also serves as a sounding chamber which adds a certain quality to the voice. This space is increased

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by the nasal sinuses which are cavities in the bones surrounding the nose. The sinuses connect with the nose by small openings. These openings are liable to close in nasal infections, thus changing the quality of the voice and occasionally causing severe infections within the sinuses.

The inspired air then passes out of the nose into the naso-pharynx, past the epiglottis and into the larynx, or voice box, which is continuous with the trachea. The larynx is composed of plates of cartilage. The vocal cords lie within the larynx as two V-shaped bands of tissue. During ordinary respiration they are widely separated permitting unobstructed flow of air. While speaking the cords come together leaving a narrow opening. As expired air passes this narrowing, the cords vibrate producing sound. The larynx also guards the trachea, preventing foreign material from passing. Any irritation in the area of the larynx produces the cough reflex. This reflex closes the vocal cords against a forced expiratory effort. Sudden opening of the cords releases a strong current of air which expels any foreign matter.

Fig. 51 The Alveoli

Occasionally in severe respiratory infections the vocal cords become swollen, interfering with the free passage of

air. It then becomes necessary to make an artificial opening into the trachea to permit the patient to breathe.

The trachea lies just in front of the esophagus. It is composed of a series of incomplete rings of cartilage. This forms a pipe that will not collapse with changes in pressure. After about four inches the trachea divides into two bronchi, one entering the right and the other the left lung. These redivide into numerous bronchioles, which finally end in small air sacs, the alveoli. It is about these alveoli that the pulmonary capillaries are found and the exchange of gases takes place. The hemoglobin of the red blood cells takes on oxygen from the inspired air and gives off carbon dioxide, which is expired. The colour of the blood is changed at this point from dark red to light red.

The chest, or thorax, is formed like a cage by the ribs. It is cone shaped, the floor being the dome-shaped diaphram. The right and left lungs are separated by the heart and great blood vessels.

There are two mechanisms at work filling the lung with air; diaphragmatic and thoracic breathing. Diaphragmatic breathing is accomplished when the muscular diaphram contracts and straightens. This increases the thoracic space and thus lowers its air pressure. The atmospheric pressure being greater, air rushed in through the nose and extends the alveoli. Thoracic breathing is accomplished by small muscles between the ribs, the intercostal muscles. As these contract the ribs are raised and the chest expands laterally. This increases the thoracic space, lowering the intrathoracic pressure, and air must rush into the lungs from the higher pressure outside. Inspired air is expired as the muscles relax, and elasticity of the tissue of the

lung and thoracic cage return the chest to the expiratory state.

This rythmical lowering of intrathoracic pressure serves an additional function. Venous blood is drawn into the large veins in the chest thus aiding the return of blood to the heart.

Oxygen must be supplied to the tissues continuously. The brain is most sensitive to any interruption in its oxygen supply. Only a few minutes without oxygen can cause death due to destruction of vital centers in the brain. Thus cessation of respiration is an acute emergency. This may happen in a number of ways. An electric shock may temporarily stun the respiratory center in the brain. An over dose of gases, such as carbon monoxide gas from the exhaust of automobiles, may depress the respiratory center. Drowning is the most common cause of respiratory arrest in our villages. In drowning a few drops of water enter the larynx and trachea and cause the vocal cords to close reflexly. They remain in a state of of spasm, and the patient soon becomes unconscious, and all respiratory efforts cease due to lack of oxygen to the vital centers of the brain. But the heart may continue to beat for long periods of time after respiration has failed.

Most patients whose respiration has stopped, but who still have a heart beat, can be saved by artificial respiration. It is best for the first aider not to try to determine whether or not the heart is still functioning. It may be beating feebly and not be easily detected. Artificial respiration should be started immediately. The best method involves both compression and expansion of the thoracic cage. The patient is placed on his abdomen with the head slightly lower than the feet. The head should be turned to one side resting on his hands. The mouth

should be inspected to make sure the tongue is forward. Drowning people frequently swallow their tongues. The

Fig. 52 Artificial Respiration

first aider then kneels by the patient's head. The first motion is to place your palms over the lower ribs. Second, with the arms held straight slowly shift the weight of your body upon the patient. Third, release pressure on the back and pull both elbows upward and forward. Fourth, return the elbows to the ground and rest. The first three steps take one second each followed by a two second rest.

Thus one respiration is completed in five seconds. Continue artificial respiration until normal breathing returns or the patient is declared dead by a doctor. Do not give up in less than four hours.

CHAPTER XXIX

THE URINARY SYSTEM

The function of the urinary system is purification of the blood. This is done by the kidneys in the formation of urine. The ureters, bladder and urethra merely conduct the urine to the outside world.

The kidneys are located on each side of the lumbar spine. The ureters carry the urine from each kidney to the bladder which is protected within the pelvic girdle, or pelvic portion of the abdominal cavity. The bladder is continuously being filled with urine. When 6 or 8 ounces have accumulated the urge to urinate is felt. At this time the muscles in the bladder wall contract. A band of circular voluntary muscles guards the bladder outlet. Relaxation of these muscles permits the urine to pass through the urethra to the outside.

Entering the kidney is a large artery carrying impure blood. This may be in the form of waste products containing nitrogen from the body protein or protein of food. Or the blood may contain excess of acid or alkaline salts or both. Many poisons and medicines are excreted through the kidneys. Finally excess of water in the body forms the fluid part of urine in which other wastes are in solution. Leaving the kidney is a large vein returning

purified (but not oxygenated) blood to the heart, and the ureter carrying urine to the bladder.

The formation of urine is mainly accomplished by a filtering process from a group of capillaries known as the glomerulus into tiny tubules, the uriniferus tubules. Ten lakhs of these tubules lie in the outer layer of each

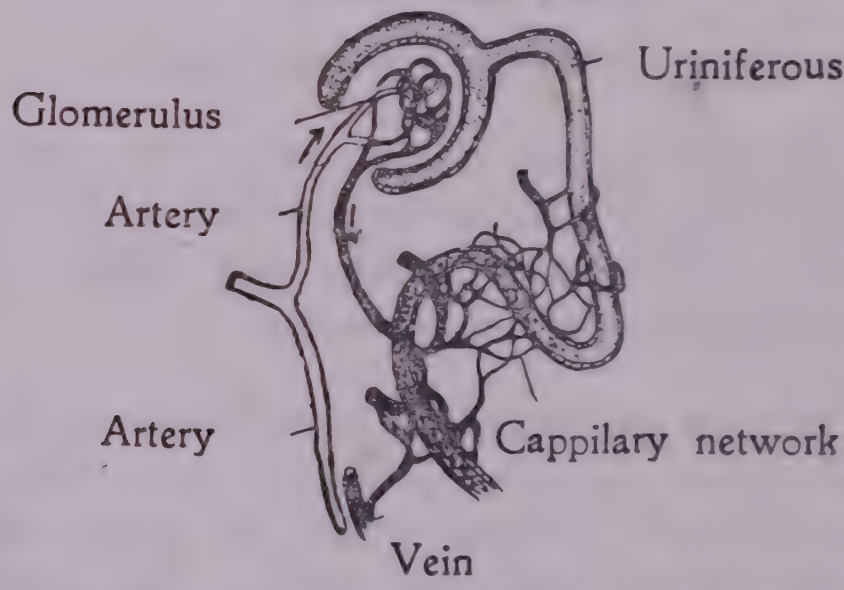

Fig. 53 The Glomerulus and Uriniferus Tubule.

kidney. The filtrate entering the tubules consists of the plasma without the plasma proteins. But soon after entering the tubules this filtrate begins to be reabsorbed into the blood stream by a second set of capillaries. About 99% of the filtrate is reabsorbed returning all normal constituents of the plasma. What remains is urine. The urine is collected in larger and larger tubules and finally leaves the kidney in the ureter.

It is easier for the kidneys to eliminate waste products in a large amount of urine. It is therefore advisable to drink more water in warm weather when much fluid is lost in sweat, and little may be left for urine.

The occurence of pus or blood in the urine may be a symptom of serious disease. Older men are apt to

have difficulty in passing urine due to enlargement of the prostate gland. This gland surrounds the urethra as it leaves the bladder and may compress it. People with these symptoms should seek the advice of a doctor.

CHAPTER XXX

THE ENDOCRINE SYSTEM

Endocrine glands secrete substances called hormones into the blood stream. These hormones have a regulating action over many functions of the body. The glands are widely distributed. Many hormones are interrelated, the production of one influencing that of another.

The pituitary gland is a small gland located in the base of the skull. The anterior part of this gland secretes several hormones that regulate the activities of all other endocrine glands. It is therefore described as the master gland of the body.

The growth hormone of the anterior pituitary gland controls the growth of the body. Deficiency of this hormone is one cause of a person being a dwarf. Over production produces giants.

The thyrotropic hormone of the anterior pituitary gland controls the activity of the thyroid gland in the production of thyroxin. The production of these two hormones is delicately balanced. An increase in thyrotropic hormone increases the production of thyroxin. But the increased thyroxin inhibits further production of thyrotropic hormone. The thyroid gland is located just below the larynx. Thyroxin contains iodine. If iodine is deficient in the diet, the gland becomes enlarged producing a goiter.

The enlargement may be thought of as an attempt to produce more thyroxin. Thyroxin affects every cell of the body, regulating metabolism of the tissues, or the rate oxygen is used and carbon dioxide is produced by the cells. Deficiency of thyroxin causes slowness of mind

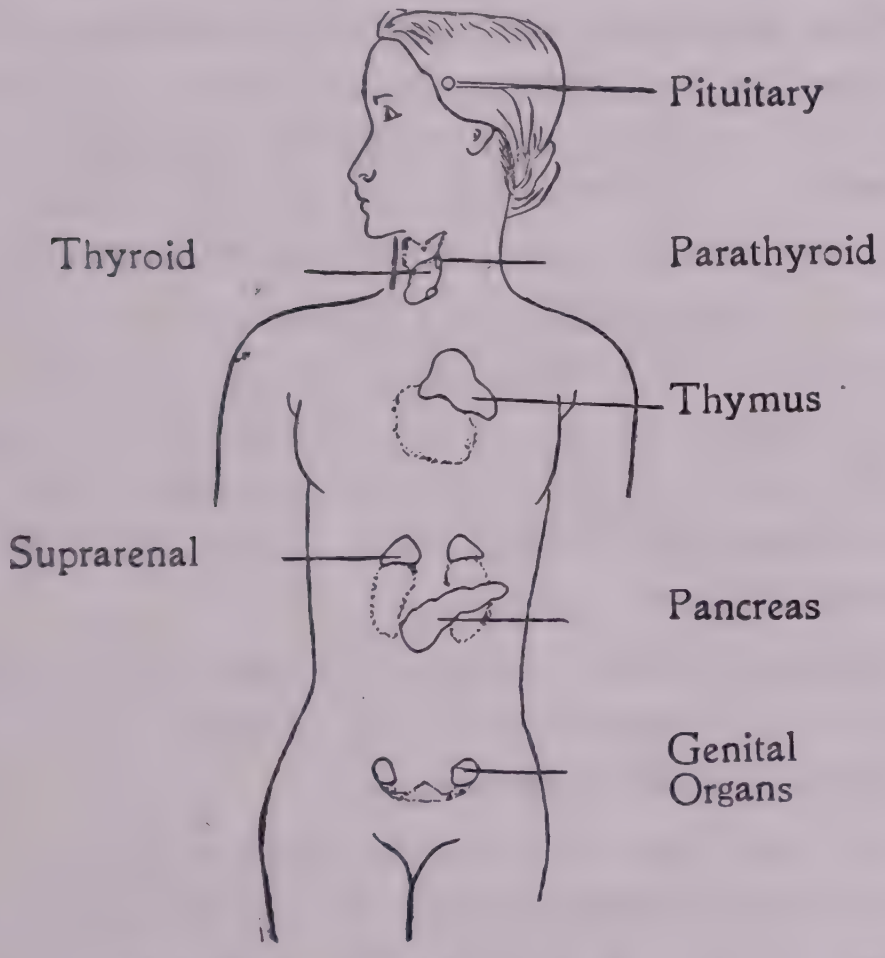

Fig. 54 The Endocrine System

and speech. In children physical and mental growth is retarded. Over-production of thyroxin causes nervousness and loss of weight. Occasionally the eyeballs protrude and generally the thyroid gland is enlarged.

The parathyrotropic hormone of the anterior pituitary gland controls the production of parathormone by the parathyroid glands. These glands are four in number and are located under the thyroid gland. Parathormone regulates the concentration of calcium in the blood. Deficiency of

parathormone causes tetany, characterized by muscular twitching and spasm. Overactivity of the parathyroid glands is generally associated with enlargement of the glands. Calcium is drawn out of the bones into the blood. As a result the bones become soft and deformed.

The pancreaticotropic hormone controls the production of insulin by the pancreas. Insulin controls the level of glucose in the blood. Over-production of insulin produces low levels of glucose. Under-production causes elevated blood sugar levels, a condition known as diabetes mellitus.

The adrenocorticotropic hormone (A.C.T.H.) controls the production of a group of hormones from the outer layer, or cortex, of the adrenal glands. These glands lie one above each kidney. The hormones from these glands have a variety of actions. They help the body meet situations of severe stress.

Prolactin is also produced by the anterior pituitary. It controls the preparation of the breasts for the production of milk during pregnancy.

At least two gonadotropic hormones are secreted by the anterior pituitary gland. These control the hormones produced in the sex glands. The female sex glands, the ovaries, produce estrogen and progesterone. These hormones are responsible for the feminine characteristics of a woman, such as her high-pitched voice, development of the breasts, lack of a beard, etc. They also control the monthly menstrual periods. The male sex glands, the testes, produce testosterone which is responsible for the manly characteristics of man, such as his low voice, beard, muscular development, etc.

The posterior part of the pituitary gland secretes three hormones. Pitressin influences involuntary muscles

of the body. Pitocin stimulates contraction of the uterus, the organ in which the baby develops in the mother. The anti-diuretic hormone influences the amount of urine formation.

The functions of these glands have been discovered by observing the results of removing the glands or giving excessive doses of the various hormones. Many of these hormones are useful in the treatment of disease. Occasionally it is necessary to remove a gland to cure a disease.

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CHAPTER XXI

THE REPRODUCTIVE SYSTEM

From the point of view of the biologist, the reproductive system is the most important of all the systems of the body as it is concerned with preservation of the species. For a new individual to be formed there must be a meeting of the germ cells, which is fertilization. Each germ cell contains only half the usual number of chromosomes. In fertilization the normal number is restored and characteristics of each parent contribute to the new individual. The female germ cell is the ovum, which develops in the ovary. The male germ cell is the spermatozoon, which develops in the testicle. These germ cells mature at adolescense along with the sex characters of the male and female.

The organs of reproduction are closely related to the urinary system and in the male the two are actually connected. The female organs lie within the bony pelvis, while the male organs lie mainly outside the pelvis.

The female organs are connected with the outside world by the vagina, which forms a passage to the uterus between the bladder in front and rectum behind. It is a tubular organ in which the spermatozoa are deposited. The spermatozoa travel through the cavity of the uterus and into the uterine tubes, being propelled by their tails.

Many lakhs of spermatozoa, which are microscopic in size, are deposited. Only one is required to fertilize the ovum. Once each month one ovary produces one ovum

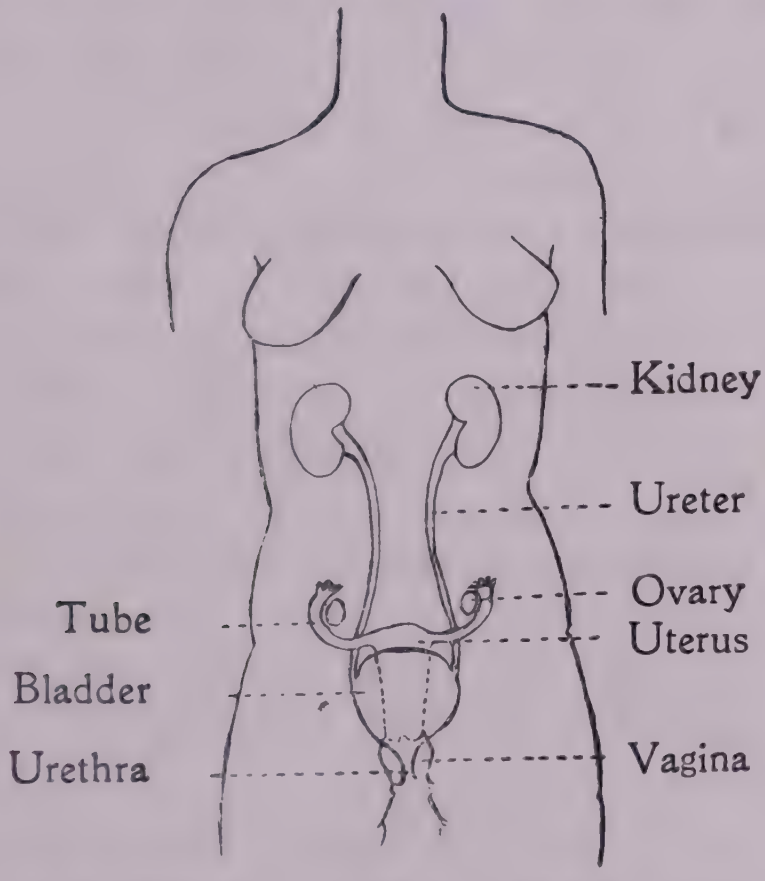

Fig. 55 The Female Reproductive Organs

which escapes into the pelvis. The ovum finds its way into one uterine tube. If a spermatozoon is present in the tube at this time, fertilization takes place. The fertilized ovum immediately begins to divide and continues through the uterine tube into the uterus, where it rests in a soft lining. There the baby developes for 9 month until birth. No new ovums are formed in this period. If the ovum fails to become fertilized, it passes out of the vagina.

The lining of the uterus is prepared anew each month to receive the ovum. The changes which take place are controlled by the two female hormones, estrogen and progesterone. Estrogen is formed in the interior of

the ovary. Progesterone is formed at the site of rupture of the ovum from the ovary. These cyclic changes involve the shedding and reforming of the entire lining of the uterus approximately every 28 days. As the old lining is shed there is bleeding from the vagina for about five days. This is the menstrual period. During the next nine days the lining of the uterus is rebuilt mainly under the influence of estrogen. At about the 14th day the ovum is freed from the ovary, a process known as ovulation. At this site of rupture of the ovum from the ovary progesterone is produced, which further developes the uterine lining, making it soft and thick. The ovum can live 24 hours and spermatozoa 48 hours. So if the spermatozoa are deposited on the 12, 13, or 14th day, fertilization may take place. This assumes that ovulation actually takes place on the 14th day. There may be considerable individual variation, but about 80% of women ovulate between the 12th and 16th day. If fertilization takes place the uterine lining is preserved and becomes part of the attachment of the baby to the mother, called the placenta or after birth. If fertilization does not take place, the old lining is shed after about the 28th day and the cycle is complete. These cycles start at puberty and continue until the menopause around 45 years of age. The cycle stops because the production of female hormones is lowered at this age.

The breasts are accessory female reproductive organs which secrete milk. Their development at puberty and in pregnancy is controlled by estrogen and progesterone. The secretion of milk is controlled by prolactin. During the secretion of milk, lactation, infections occasionally occur. Prompt treatment by a doctor will save the patient much pain and avoid the necessity of an operation.

Tumors of the female reproductive organs are the most common tumors in women. They may be quite serious. Any lump in the breast or abnormal vaginal bleeding should be called to the attention of a doctor at once.

The male generative glands, the testes, are located in a sac, the scrotum. In the developing male body the testes are

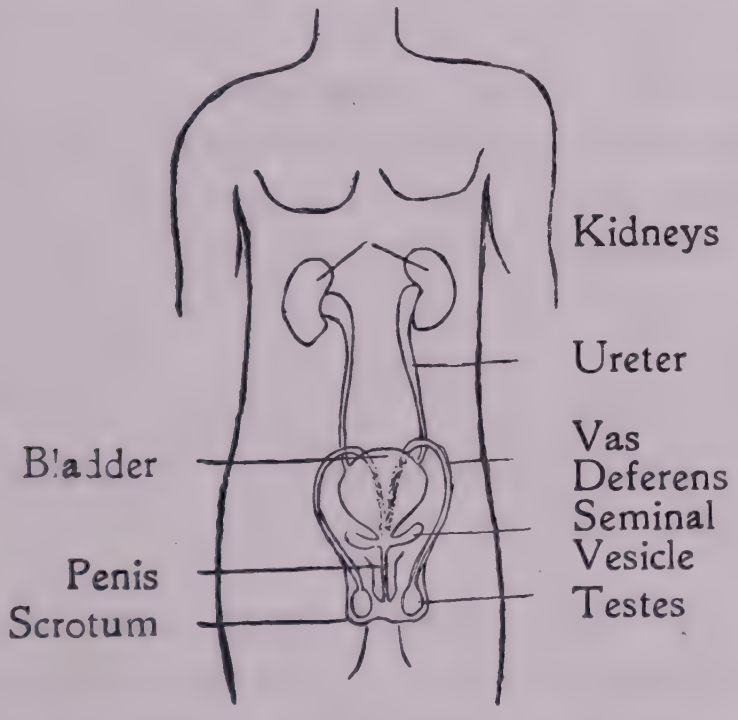

Fig 56 The Male Reproductive Organs

formed in the abdominal cavity, but shortly before birth or soon after they migrate into the scrotum. If they fail to enter the scrotum, live spermatozoa will not be produced. The spermatozoa produced in the testes enter the vas deferens which is a thin hard muscular tube connecting each testicle to the seminal vesicle. These act as storage places for spermatozoa. When the vas deferens and seminal vesicle contract the spermatozoa are forced through the ejaculatory duct into the first part of the urethra, a process known as ejaculation. The urethra is surrounded here by the prostate gland which adds its secretion during ejaculation.

The combined fluid, the semen, follows the urethra through the penis. The secretion from the testes amounts to only a drop or two of fluid, but in it are many lakhs of spermatozoa. Considerably more fluid is secreted by the prostate gland. This fluid serves as a media in which the spermatozoa are suspended.

Removal of the testes, or castration, results in loss of spermatozoa formation and testosterone production. Thus fertilization becomes impossible and the male characteristics are lost. Cutting each vas deferens makes fertilization impossible but has no other effect on the man. Likewise, removing both ovaries in a woman makes fertilization impossible and also causes loss of feminine characteristics. The menstrual cycle, which is under the control of estrogen and progesterone, ceases. Tieing off the uterine tubes makes fertilization impossible but has no other effect on the woman.

The first aider may at some time be called to assist in delivery of a baby. Both the mother and child can easily become infected during delivery. Cleanliness must therefore be thought of constantly. A few items should be boiled; a scissors or knife to cut the cord, and two strips of cotton cloth to tie the cord. If time permits, the mother should wash a wide area about the vagina with soap and water. After this a clean sheet should be placed under the mother on a bed. when all is ready the first aider should wash her hands thoroughly, rinsing them with clean water, preferably boiled or chlorinated water. She should then touch nothing until the baby' s head comes through the vagina. It is not necessary to touch the mother at all. The baby's head is supported away from the mother's rectum. As the mother

pushes the baby's shoulders and body out, the baby is supported with fingers about its neck and legs. Take care; he is slippery. The baby is then placed on the mothers abdomen which is covered with a clean cloth. His head should be slightly lower than his chest to allow fluids to drain from his mouth. He will soon start to cry. The cord may now be firmly tied in two places with the boiled strips of cotton cloth, and cut between the ties with the boiled knife or scissors. The stump of cord left on the baby should be wrapped in a clean or sterile cloth. The baby may now be wrapped in a blanket and given to the mother. In a few minutes the afterbirth will be delivered. A clean cloth may then be placed between the mother's legs.

If bleeding should occur after delivery of the placenta, the mother's abdomen must be massaged. A soft mass will be felt. This is the uterus. It is gently massaged until it becomes firm. As long as the uterus is firm there will be no bleeding.

Failure of village *dais* to adhere to these simple precautions has cost the lives of innumerable mothers and infants in village India.

Infections of the reproductive organs are very common throughout the world. They are spread from man to woman and from woman to man. The two most important of these infections are gonorrhea and syphilis, each being caused by a different bacteria. Each generally causes little inconvenience to adults during the first years of infection. Each may cause serious illness later. Each may be passed on to children born to infected mothers.

Gonorrhea is an infection of the urethra in the male and the urethra, uterus and uterine tubes in the female.

The first symptom is pus discharging from the urethra or vagina. This may clear up after a few days or weeks or become chronic. If not treated at this time by a doctor an abscess may form in a uterine tube. Years later the urethra may develop a scar which slowly contracts causing difficulty in passing urine. In the newborn baby, the eyes become infected. This is an important cause of blindness. For this reason it is a rule in medicine that one drop of 1% silver nitrate solution be placed in each of the baby's eyes immediately after delivery. This practice gives certain protection to the baby. Gonorrhea is easily cured in its early stages. Later damage to the tissue is permanent.

Syphilis is a disease affecting all tissues of the body. The earliest symptom is a small sore on the penis in the male and the outlet of the uterus on the female. The lesion heals in a few days without treatment. Some months later, if untreated, a rash may appear on any part of the skin. Years later permanent damage appears in many tissues of the body as eye, bone, heart and nervous tissue. Not infrequently the patient becomes insane. A child born of a mother with syphilis is likely to have the disease. Such children are frequently mentally defective and have deformities of bones and tooth. If the mother is treated during the pregnancy the baby will not have the disease. One of the advantages of having a baby at a good hospital is that the blood of the mother is examined as a matter of routine to determine whether or not she has syphilis. The health of countless children has been saved in this way.

The control of these diseases involves the early treatment of cases at the first signs of the disease,

premarital examinations, and high moral standards in the community. Children may be protected by instilling one drop of 1% silver nitrate in each eye immediately after birth and examining the the blood of every expectant mother.

APPENDIX

APPENDIX

TABLE 1

TABLE OF NITROGEN/CARBON RATIOS

(by weight)

Ammonium nitrate	1/0.029
Ammonium sulphate	1/0.049
Nitro-lime	1/0.050
Urine	1/0.94
Oil cake	1/2.3
Feces : Night soil	1/2.7
New Fowl Dung	1/3.9
Rice bran	1/9.2
New sheep dung	1/9.7
Medicago satica* (Alfalfa, Lucerne) ...	1/9.6
Melilotus alba* (White sweet clover) ...	1/9.6
Trifolium pratense* (Red clover) ...	1/9.4
T. hybridum* (Alsike clover) ...	1/9.5
T. repens* (White clover) ...	1/9.7
T. incarnatum* (Crimson clover) ...	1/9.8
New horse dung	1 11
Green grass	1/13
Dried grass	1/14
New pig dung	1/14
New cow dung	1/15
Fallen leaves	1/21
Rice straw	1 27
Kaoliang : Jwar straw	1/32
Wheat straw	1/42
Earth	Negligible

Note :*... green manure

TABLE II

TYPICAL VILLAGE DIET

Jawar Area

Food	Ounce in diet	Calories	Protein g	Fat g	Carbohydrate g	Calcium mg
Jawar (cholam)	10	1000	30	5	210	80
Milled Rice	5	495	10	0·5	110	15
Dhal (red gram)	5	475	31.5	2·5	81	200
Milk	1	18	0.9	1	1·4	34
Linseed oil	0·5	128	...	14	...	...
Total		2116	72·4	23	402·4	329
Required		2400	82			1000

Continued TABLE II

Food	Ounce in diet	Iron mg	Vitamin A IU	Carotene IU	Vitamin B_1 IU	Vitamin C mg
Jawar	10	18	...	390	330	...
Milled Rice	5	1·5	...	...	30	...
Dhal (Red gram)	5	12·5	...	310	215	...
Milk	1	0·1	51	...	5	...
Linseed Oil	0.5	—	...	...	...	...
Total		32·1	751		580	0
Required		30	3000		330	50

TABLE III

IMPROVED DIET

Food	Ounce in diet	Calories	Protein g	Fat g	Carbohydrate g	Calcium mg
Jawar (cholam)	10	1000	30	5	210	80
Rice (home Pounded)	5	500	12	1	111	15
Dhal (sprouted)	5	475	31.5	2.5	81	200
Milk (skimmed)	8	64	5.6	0.5	10.4	272
Carrot	4	52	1.2	...	12	92
Til cake	1	60	5.2	4	7.1	410
Guava	1	19	0.4	0.4	4.1	3
Linseed oil	1	256	...	28	...	...
Total		2426	82.9	41.4	432.6	1072

Continued TABLE III

Food	Ounce in Diet	Iron mg	Vitamin A IV	Carotene IU	Vitamin B_1 IU	Vitamin C mg
Jawar (cholam)	10	18	...	390	330	...
Rice (home Pounded)	5	4	...	5	85	...
Dhal (sprouted)	5	12.5	...	310	215	25
Milk (skimmed)	8	0.8	...	...	...	...
Carrot	4	1.6	...	3200	68	4
Til cake	1	3	...	28	...	...
Guava	1	3.0	...	...	...	85
Linseed oil	1	...	...	...	...	...
Total		39.9	0	3933	698	114

TABLE IV

MINIMUM DAILY NUTRITIONAL REQUIREMENTS

Adults.

Protein. One gram per kilogram of body weight.
Fat. Unknown. A small amount of unhydrogenated fat is required.

Carbohydrate. Enough to give adequate calories to maintain an ideal weight.

Calcium. One gram.

Calories. Enough to maintain an ideal weight. This varies with age sex and occupation.

Vitamin A. 3000 International Units.

Vitamin B_1. 330 International Units.

Vitamin C. 50 milligrams.

Children require the same amount of minerals and vitamins as adults, but proportionately to their weight more protein and less carbohydrate and fat.

TABLE VI

TABLE OF FOOD VALUES

VALUES PER CHATANK

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
CEREALS	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Bajra	6.6	2.8	38.2	28	5.6	204	126	188	—
Cholam	6.0	1.0	42.0	16	3.2	202	78	196	—
Buckwheat	5.8	1.4	36.8	40	7.6	184	—	512	—
Maize, tender	2.4	0.2	8.6	6	0.4	46	24	68	1
Maize, dry	6.4	2.0	37.6	6	1.2	194	—	238	—
Panivaragu	7.2	0.6	39.2	6	3.2	190	Trace	—	—
Ragi	4.0	0.8	43.4	188	3.0	196	40	238	—
Rice, raw homepounded	4.8	0.4	44.4	6	1.6	200	2	102	—
Samai	4.4	2.6	36.2	12	4.0	186	Trace	17	—
Sanwa millet	3.6	1.2	37.2	12	1.6	174	Trace	—	—

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Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit A	Vit B_1	Vit C
CEREALS	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Varagu	4.8	0.8	37.2	20	3.0	174	Trace	188	—
Wheat, whole	6.8	0.8	0.4	28	3.0	196	62	306	—
Wheat, flour, whole	6.8	1.0	41.0	22	4.0	200	—	—	—
Wheat, refined	6.2	0.6	42.0	12	0.6	198	—	22	—
PULSES									
Bengal gram	9.8	3.0	34.8	108	5.6	206	180	56	—
Black gram	13.6	0.8	34.2	120	5.6	198	36	238	—
Cow gram	14.0	0.4	31.6	40	2.2	186	34	284	—
Field beans, dry	14.2	0.4	34.0	40	1.2	198	Trace	296	—
Green gram	13.6	0.8	32.2	80	4.8	190	90	264	—
Lentil	14.2	0.4	34.0	74	1.2	196	256	256	—
Peas, dried	11.2	0.6	32.2	40	2.6	178	—	256	—
Peas, roasted	13.0	0.8	36.0	16	2.8	204	—	—	—

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Continued from Page No. 182

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
PULSES	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Red gram	12.6	1.0	32.4	80	5.0	190	124	256	—
Soya bean	24.6	11.0	11.8	140	6.6	246	404	414	—
LEAFY VEGETABLES									
"Agathi"	4.8	0.8	6.6	640	2.2	52	5.140	—	—
Amaranth, tender	2.8	0.2	3.2	280	12.2	26	1,420 to 6,240	16	98
Amaranth, spined	1.8	0.2	4.6	440	13.0	26	—	—	—
Bamboo, tender shoots	2.2	0.2	4.2	12	0.2	26	Trace	—	—
"Bathua"	2.6	0.2	2.0	84	2.4	22	—	—	—
Bengal gram leaves	4.0	0.8	6.6	194	13.6	50	—	—	—
Cabbage	1·0	0·2	3·6	16	0·4	18	1,136	34	70
Carrot leaves	2·8	0·2	4·6	192	5·0	32	—	—	—

Continued on Page No. 184

Continued from Page No. 183

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Celery	3·4	0·4	2·8	130	3·6	36	3,294 to 4,260	Trace	36
Coriander	1·8	0·4	3·6	80	5·6	26	5,940 to 7,160	28	76
Curry leaves	3·4	0·6	9·0	460	1·8	56	7,160	46	2
Drumstick leaves	3·8	1·0	7·6	240	2·0	54	6,420	34	124
Gram leaves	4·6	0·2	15·4	176	16·0	82	3,806	—	—
Khesari leaves	3·4	0·6	4·4	90	4·2	36	3,408	—	—
Lettuce	1·2	0·2	1·8	28	1·4	14	1,250	22	8
Rape leaves	2·8	0·2	4·0	210	7·2	30	—	—	—
Safflower leaves	1·8	0·4	2·8	102	4·4	22	3,124	—	—

Continued on Page No. 185

Continued from Page No. 184

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Spinach	1·0	0·6	2·2	34	2·8	18	1,476 to 1,988	28	28
Soya leaves	3·4	0·2	6·2	102	4.6	40	—	—	—
ROOTS AND TUBERS									
Beet root	1·0	0·2	7·8	114	0·6	38	Trace	22	50
Carrot	0·6	0·2	6·0	46	0·8	26	1,136 to 2,442	22	2
Colocasia	1.8	0.2	12.6	22	1.2	58	22	52	Trace
Onion, big	0.6	0.2	6.6	100	0.4	28	—	46	6
Onion, small	1.0	0.2	7.4	20	0.6	34	14	46	6
Potato	1.0	0.2	13.0	6	0.4	56	2	56	12

Continued on Page No. 186

Continued from Page No. 185

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Radish (pink)	0.4	0.2	4.2	20	0.2	20	2	34	10
Radish (White)	0.4	0.2	2.4	20	0.2	12	2	17	4
Sweet potato	0.6	0.2	17.6	12	0.4	74	6	46	14
Tapioca	0.4	0.2	21.8	20	0.4	90	—	26	—
Yam elephant	0.6	0.2	10.4	20	0.4	44	246	34	Trace
OTHER VEGETABLES									
Ash gourd	0.2	0.2	1.8	16	0.2	8	Trace	36	2
Bitter gourd	1.0	0.2	2.4	12	1.2	14	120	40	50
Broad beans	2.6	0.2	5.6	28	1.0	34	—	46	6
Brinjal	0.8	0.2	3.6	120	0.8	20	2	26	12
Calabash cucumber	0.2	0.2	1.6	12	0.4	8	Trace	—	—
Cauliflower	2.0	0.2	3.0	16	0.8	22	22	56	38
Cluster beans	2.2	0.2	5.6	74	3.2	32	188	—	28

Continued on Page No. 187

Continued from Page No. 186

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit A	Vit B_1	Vit C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Cucumber	0.2	0.2	1.6	6	0.4	8	Trace	16	4
Double beans	4.8	0.2	7.0	2	1.4	58	—	—	12
Drumstick	1.4	0.2	2.0	16	3.0	14	104	28	68
French beans	1.0	0.2	2.6	28	1.0	14	126	44	8
Jack, tender	1.4	0.2	5.4	16	1.0	28	—	28	—
Jack fruit seeds	3.8	0.2	21.8	28	0.6	104	—	—	—
Knol-khol	0.6	0.2	3.4	12	0.2	18	20	28	48
Ladies finger	1.2	0.2	4.4	50	0.8	24	32	36	8
Mango, green	0.4	0.2	5.0	6	2.6	22	86	22	2
"Nellikai" (amla)	0.2	0.2	8.0	28	0.6	34	—	16	340
"Parwar"	0.2	0.2	1.0	16	1.0	10	—	—	—
Peas English	4.0	0.2	11.2	12	0.8	62	78	142	6
Plantain flower	0.8	0.2	2.8	16	0.2	16	—	28	—
Plantain green	0.8	0.2	8.4	6	0.4	38	28	26	14

Continued on Page No. 188

Continued from Page No. 187

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Plantain stem	0.2	0.2	5.4	6	0.6	24	—	12	—
Pumpkin	0.8	0.2	3.0	6	0.4	16	48	34	2
Ridge gourd	0.2	0.2	2.0	22	1.0	10	32	38	—
Singhara	2.6	0.2	13.6	12	0.4	66	12	28	—
Snake-gourd	0.2	0.2	2.4	28	0.8	12	90	22	Trace
Sword beans	1.6	0.2	3.6	34	1.2	22	22	46	—
"Tinda"	1.0	0.2	3.0	12	0.6	16	16	—	—
Tomato, green	1.0	0.2	2.6	12	1.4	16	182	40	18
Turnip	0.2	0.2	4.2	16	0.2	20	Trace	22	24
Vegetable marrow	0.2	0.2	2.4	6	0.4	12	Trace	—	10
NUTS AND OIL SEEDS									
Almonds	11.8	33.4	6.0	130	2.0	372	Trace	136	—
Cashewnut	12.0	26.6	12.6	28	2.8	338	56	358	—

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Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Coconut	2.8	23.6	7.4	6	1.0	252	Trace	26	Trace
Gingelly seeds	10.4	24.4	14.2	820	6.0	320	56	574	—
Groundnut	15.2	22.6	11.6	28	1.0	312	36	512	—
Groundnut roasted	17.8	22.6	11.0	28	0.2	318	—	—	—
Linseed seeds	11.6	21.0	16.4	96	1.6	302	28	—	—
Mustard seeds	12.4	22.4	13.4	280	10.2	302	154	370	Trace
Pistachio	11.2	30.2	9.2	80	7.8	356	136	380	—
Walnut	8.8	36.6	6.2	60	2.8	390	6	256	—
CONDIMENTS, SPICES, ETC.									
Asafoetida	2.2	0.6	38.4	380	12.6	168	—	—	—
Cardamom	5.8	1.2	23.8	74	2.8	130	—	—	—
Chillies, green	1.6	0.4	3.4	16	0.6	24	128	—	62
Chillies, dry	9.0	3.6	18.0	90	1.4	140	32	—	28

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Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Cloves, dry	3.0	5.0	27.2	420	2.8	166	—	—	—
Cloves, green	1.4	3.4	13.6	176	1.2	90	68	—	—
Coriander	8.0	9.2	12.2	360	10.2	164	890	—	Trace
Garlic	3.6	0.2	16.4	16	0.8	80	—	—	8
Ginger	1.4	0.6	7.0	12	1.4	38	38	—	4
Mustard	12.4	22.4	13.4	240	10.2	308	154	—	Trace
Tamarind pulp	1.8	0.2	38.2	96	6.2	164	56	—	2
Tumeric	3.6	2.8	39.4	86	10.6	198	28	—	—
FRUITS									
Apple	0.2	0.2	7.6	6	1.0	32	Trace	66	2
Banana	0.8	0.2	20.6	6	0.2	86	Trace	86	2
Bilimbi	0.2	0.2	2.8	6	0.2	14	136	—	—
Bread fruit	0.8	0.2	10.2	22	0.2	44	8	—	—

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Continued from Page No. 190

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Bullock's heart	0.8	0.2	11.8	6	0.4	52	Trace	—	—
Cashew fruit	0.2	0.2	6.6	6	0.2	28	—	—	—
Dates	1.8	0.2	38.2	40	6.0	160	340	52	Trace
Figs	0.8	0.2	9.6	34	0.6	42	154	—	2
Grapes (Blue variety)	0.4	0.2	5.8	16	0.2	26	8	22	2
Grapefruit	0.4	0.2	4.0	12	0.2	18	—	68	18
Guava, country	0.8	0.2	8.2	6	0.6	38	Trace	16	170
Guava, hill	0.2	0.2	4.6	28	0.6	22	Trace	—	8
Jack fruit	1.0	0.2	10.8	12	0.2	8	306	16	6
Jambu fruit	0.4	0.2	11.2	12	0.6	48	—	—	—
"Karwanda" dry	1.4	5.4	38.0	90	22.2	206	—	—	—
Lemon	0.6	0.6	6.2	40	1.4	32	Trace	12	22
Lime	0.8	0.6	6.2	50	0.2	34	14	12	36
Loquat	0.4	0.2	5.8	16	0.4	26	—	—	—

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Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit A	Vit B_1	Vit C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Mango, green	0.4	0.2	5.0	6	2.6	22	86	—	2
Mango, ripe	0.4	0.2	6.6	6	0.2	28	2,726	22	8
Melon, water	0.2	0.2	2.2	6	0.2	10	Trace	12	2
Orange	0.6	0.2	6.2	28	0.2	28	198	68	38
Orange, Washington, Navel	0.4	0.2	5.2	12	0.2	22	—	—	—
Orange, Jaffa	0.4	0.2	4.6	12	0.2	20	—	—	—
Palmyra, fruit tender	0.4	0.2	3.6	6	0.2	16	—	—	2
Rose apple	0.4	0.2	5.4	6	0.2	24	—	—	—
Papaya, ripe	0.2	0.2	5.4	6	0.2	22	1,146	22	26
Peaches	0.8	0.2	4.2	6	1.0	22	Trace	12	2
Pears, country	0.2	0.2	6.6	6	0.4	26	8	12	Trace
Persimmon	0.4	0.2	10.8	6	0.2	46	970	—	—
Pineapple	0.4	0.2	6.8	12	0.6	28	34	—	36
Plantain (ordinary)	0.6	0.2	14.0	6	0.2	60	70	28	4

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Continued from Page No. 192

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A	Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
Plantain hill	0.6	0.2	10.2	6	0.2	44	70	—	6
Plum (red-variety)	0.4	0.2	5.0	12	0.2	22	130	68	2
Pomegranate	1.0	0.2	8.2	6	0.2	36	—	—	10
Pomeloe	0.4	0.2	5.8	16	0.2	24	114	16	12
Radish fruit	1.4	0.2	3.0	40	1.6	20	—	—	—
Raisins (preserved)	1.2	0.2	43.8	60	2.2	182	—	34	Trace
Tomato, ripe	0.6	0.2	2.2	6	0.2	12	182	68	18
Tree tomato	0.8	0.2	5.8	6	0.4	28	306	—	Trace
Wood-apple	4.2	0.4	8.8	74	0.4	56	—	—	—
Tamarind, pulp	1.8	0.2	38.2	96	6.2	164	56	34	2
Zizyphus	0.4	0.2	7.2	16	0.4	32	40	—	—
FLESH FOODS									
Cat Fish	12.2	—	—	6	—	48	—	—	—

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Name	Protein g.	Fat g.	Carbo-hydrate g.	Calcium mg.	Iron mg.	Caloric Value	Vit. A IU	Vit. B_1 mg.	Vit. C mg.
MILK AND MILK PRODUCTS									
Milk, cow's	1.8	2.0	2 8	68	0.2	36	102	28	2
Milk, buffalo's	2.4	5.0	2.8	120	0.2	66	92	22	—
Milk, goat's	2.2	3.2	2.8	96	0.2	48	104	—	—
Milk, human	0.6	2 2	4.0	12	0.2	38	118	—	—
Curds	1.6	1.6	1.8	68	0.2	28	74	—	—
Butter-milk	0.4	0.6	0.2	16	0.4	Trace	—	—	—
Skimmed milk	1.4	0.2	2.6	68	0.2	16	—	—	2
Skimmed milk powder	21.4	0.2	28.8	780	0.8	202	—	32	—
Cheese	13.6	14.2	3.6	440	1.2	198	154	—	—
"Koa" (whole buffalo milk)	8.2	17.8	11.6	360	3.2	240	—	—	—

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Continued from Page No. 194

Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit. A		Vit. B_1	Vit. C
	g.	g.	g.	mg.	mg.		IU		mg.	mg.
"Koa" (skimmed buffale milk)	12.6	1.0	14.6	560	1.6	118	—		—	—
MISCELLANEOUS FOODSTUFFS										
								Carotsne		
Betel leaves	1.8	0.4	3.4	130	3.2	24	—	2,726	40	2
Coconut tender	0.6	0.8	3.6	6	0.6	22	—	—	—	2
Coconut water	0.2	0.2	2.2	12	0.2	10	—	—	—	2
Cod liver oil	—	56.8	—	—	—	512	14,080 to 113,600	—	—	—
Jaggery	0.2	0.2	54.0	46	6.2	218	—	158	12	—
"Pappads"	10.6	0.2	29.6	46	9.8	164	—		—	—
Sago	0.2	0.2	49.4	12	0.8	200	—		—	—

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Name	Protein	Fat	Carbo-hydrate	Calcium	Iron	Caloric Value	Vit A	Vit B_1	Vit C
	g.	g.	g.	mg.	mg.		IU	mg.	mg.
"Singhara" dry	7.6	0.4	39.0	40	1.4	190	—	—	—
							Carotene		
Sugar cane juice	0.2	0.2	5.2	6	0.6	22	—	6 —	—
Toddy, sweet	0.2	0.2	8.2	86	0.2	34	—	— 8	—
Toddy, sweet (coccnut)	0.2	0.2	2.0	22	0.6	8	—	— 8	—

TABLE VI

TABLE OF EQUIVALENTS

1 gram (g)	1000 milligram (mg)
1 kilogram (kg)	2.2 pounds (lbs)
	1000 grams
1 ounce (oz)	28.4 grams
1 tola	11.6 grams
1 seer	2 pounds
	907.2 grams
1 chhatak	2 ounces
1.0 milligram carotene	1,666 international units (IU) Vit. A
1.0 milligram Vitamin A	3,300 International Units
1.0 milligram Thiamine hydrochloride	333 IU Vit. B_1
1.0 milligram Ascorbic Acid	20 IU Vit. C
1.0 milligram Calciferol	40,000 IU Vit. D.
1.0 milligram	1,000 micrograms

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India lives in her seven lakhs of villages, obscure, tiny, out-of-the-way villages, where the population in some cases hardly exceeds a few hundred, very often not even a few score. That is real India, my India, for which I live. You cannot take to these humble people the paraphernalia of highly qualified doctors and hospital equipment. In simple natural remedies and Ramanama lies their only hope.

Harijan 7-4-46 **M. K. Gandhi**

I hold that where the rules of personal, domestic and public sanitation are strictly observed and due care is taken in the matter of diet and exercise, there should be no occasion for illness or disease. Where there is absolute purity, inner and outer, illness becomes impossible.

Harijan 26-5-46 **M. K. Gandhi**